MEASURING ACCESSIBILITY OF HEALTHCARE SERVICES IN CHAMARAJANAGARA TALUK, KARNATAKA

THESIS SUBMITTED TO

UNIVERSITY GRANTS COMMISSION
POST DOCTORAL FELLOWSHIP FOR WOMEN (PDFWM)
NEW DELHI

FOR THE AWARD OF

POST- DOCTORAL RESEARCH PROGRAMME

BY

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(F.15-1/2015-17/PDFWM-2015-17-KAR-33194 (SA-II) Dated: 12-10-2015)

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JULY – 2021

DECLARATION

I hereby declare that the thesis entitled "***MEASURING ACCESSIBILITY OF HEALTHCARE SERVICES IN CHAMARAJANAGARA TALUK, KARNATAKA***" submitted for the award of Post-Doctorate Degree in the Department of Studies in Geography, University of Mysore is my original study and that this thesis has not formed the basis for the award of any degree/diploma/associateship/fellowship or any similar title of any other University or Institute.

Dr. Divya.S

Date:

Place: Mysuru

CERTIFICATE

This is to certify that thesis entitled *"MEASURING ACCESSIBILITY OF HEALTHCARE SERVICES IN CHAMARAJANAGARA TALUK, KARNATAKA"* is a bonafide record of research work carried out by **Dr. DIVYA.S**, Post-Doctoral Fellow of University Grants Commission (PDFWM), **(F.15-1/2015-17/PDFWM-2015-17-KAR-33194 (SA-II) Dated: 12-10-2015)** in the Department of Studies in Geography, University of Mysore during the period of study (2015-2020) under my guidance.

It is also certified that the above work has not previously formed the basis for the award of any degree, diploma and associateship or fellowship or similar titles to the candidate. This research work of the candidate is an original contribution.

Signature of Supervisor **Signature of Chairperson**

Date:

Place: Mysuru

ACKNOWLEDGEMENT

All praise due to God, the Most Gracious and Most Merciful, for giving me the strength, health to complete my work with zeal and zest. The sense of contentment and elation that accompanies the successful completion of the thesis would be incomplete without mentioning the names of the people who have helped in accomplishing this Research work.

It gives me immense pleasure to express gratitude to my esteemed supervisor ***Dr. Chandrashekara.B****, Professor, Department of Studies in Geography, University of Mysore, Manasagangothri, Mysore, under who's valuable and meticulous supervision, the present study has brought to its logical conclusion. I have no words to acknowledge his constant inspiration during my work under his supervision.*

I take this opportunity to thank ***Prof. Jayashree.P****, Chairperson, Department of Studies in Geography, University of Mysore, Mysore, for providing a healthy environment in the department.*

I would like to express my sincere thanks to all faculty members of the Department of Studies in Geography, University of Mysore, Mysore, ***Prof. Nagaraj.H, Prof. Asima Nusrath, Prof. S. Arun Das, Prof. Ramu, Dr. Y. P. Rajesh*** *and all Non-Teaching Staff. My sincere thanks to our beloved* ***Professor Late. Subash S.S*** *for his encouragement during the research work.*

My special thanks go to Dr. Javaid Ahmad Tali for his continuous help and valuable suggestions.

My humble gratitude is highly extended to the funding sources that made my Post-Doctorate research work possible. I was funded by University Grants Commission under Post-Doctoral Fellowship for Women (PDFWM), New Delhi. I am honored for facilitating financial support in the completion of my research work.

I am also thankful to the Census Department, Bengaluru, Government of Karnataka and District Health Office, Staffs of Primary Health Centers, Chamarajanagara for providing related data and for their valuable suggestions.

I would like to convey my thanks to Dr. Minutha V, Dr. Sowmya. R and Dr. Mangalagowri.B for their help and encouragement.

My heartfelt thanks to my family members, whose blessings, good wishes and prayers gave me strength to carry out my research work, especially my beloved parents Mr. Shivamallu.H.S and Mrs. Nagamani.S, My Brother-Mr. Muralidhar.S (Florida, USA) and My

Sisters - Manjula, Mamatha and Bhavya, My Niece and Nephews (Lavanya, Poorvik, Yashaswini, Raghav, Rishitha, Vibha and Gargi), Specially My Husband - Mr. Karthik and my in laws for their support and encouragement. My thanks due to all my relatives and friends for their support and encouragement during my research work.

Last but not the least; I would like to thank all those who have helped me directly or indirectly to complete this work.

Dr. Divya S

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CHAPTER – I

INTRODUCTION

1.1: Introduction

In all sectors of human life, health is one of the most significant elements to improve the functional system and attaining the higher standard of living in the community. India has made a significant progress in all fields of life including health. It has eradicated a variety of diseases such as smallpox and plague. The mortality rate has decreased and the life expectancy rate has improved due to the enormous change in the health system sector. People are also suffering from a variety of communicable and debilitating diseases, amid all the growth in the healthcare system. This condition is undermining people's physical, mental and social well-being and thus impacting the country's economic growth (Sharma 1984). Thus, health is not simply a medical concern, but a societal purpose that is equally important for social and personal conduct to be accomplished.

In a nation, health is a fundamental element of any person. The well-being of the people is an underlying basis of the nation's viewpoint. People's health is determined by several factors, but the function of healthcare services is very critical. An individual might be overweight because he does not get enough food to eat or because the food he gets is not good enough to maintain his body in optimum working condition. Health is also equated with the "absence of illness." He looks frail and tired; he is unable to work hard, and loses interest in himself and in the world around him. He may become a victim of one or more diseases sooner or later. But he is just unhealthy to begin with. Nutritional deficiency and reduced immunity are his issue (Mishra R.P 2007).

In all planning activities, wellbeing that directly affects the well-being and labor productivity of the population is the essential factor. Therefore, in formulating an effective spatial organization of health care programmers, an analysis of all the factors adverse to human health and happiness is a prerequisite, which in turn is responsible for keeping up a high level of social welfare. There is therefore an imperative need for such studies to be carried out in order to define current spatial-temporal distribution levels of human diseases and health care facilities. These studies demonstrate the actual need for these pursuits and ways of preparing for them. There is a strong recognition at present of the value of recognizing the regional dimensions of human health. This understanding is part of an overall effort to strengthen intellectual horizons within the discipline of geography (Akhtar 1983).

1.2: Importance of the Study

The spatial dimensions of health care facilities, delivery networks and their usage patterns have been analyzed by a variety of geographers in the field of medical geography. Much of the study has been carried out in highly urbanized and developing nations. They focus primarily on usage trends, location decision study, hospital service supply choice and determinants of patient use of healthcare facilities, etc. Not too focused on the rural healthcare environment, healthcare infrastructure and healthcare accessibility.

In India, there is a significant lack of studies on healthcare research. Therefore, with regard to primary health centers in Chamarajanagara district, the present study is focused on examining the existence and spatial trends of healthcare services and accessibility. The district is situated in the southern portion of Karnataka State's southernmost district, the Deccan Peninsula. It is one of the backward districts of Karnataka, with comparatively very low socio-economic

indicators such as literacy, income and living standards of the population. Geographical and socio-economic factors affect the essence of the delivery and accessibility of healthcare services. Access to healthcare varies between various socio-economic classes of individuals. The spatial variance in the distribution of healthcare services is believed to affect regional accessibility to health centers. Therefore, it is important to examine spatial variance in different types of healthcare service accessibility. It is very important to consider the essence of accessibility in the area in order to make healthcare planning and health administration possible. One of the health policy priorities is to increase the accessibility of rural areas to healthcare services. It is necessary to accomplish this plan of endeavor. Through careful design and successful implementation of health policies and government services, this study will draw the attention of politicians to provide an efficient distribution of health centers and health staff to achieve the full amount of health care benefits in maximum places.

1.3: Statement of the Problem

The goal of the study is to define the spatial pattern, distribution and accessibility of healthcare services in the district of Chamarajanagara. It is the state's border district. The popular concepts that have recently gained attention in the area of medical / healthcare geography are healthcare services and accessibility. The availability, distribution and accessibility of health services varies across space, depending on the combined impact of several factors, such as geographical, economic, social , political, etc. The issue chosen for the research is to investigate the spatial patterns of distribution of healthcare services, to understand the nature of accessibility to healthcare centers and to determine the nature of accessibility of demographic groups with different socio-economic backgrounds to healthcare resources in the region of the study. Primary Health Centers provide the public with health care facilities so that individual and community

health needs and expectations can be addressed. Via PHC's, people typically get first contact with healthcare services: prevention, maintenance, diagnosis and referral. Primary healthcare has been given due importance in recent years by increasing the provision of health facilities to reach all parts of the population. The present research problem therefore focuses primarily on examining the nature of distribution in general and the nature of accessibility, in particular, to primary health centers and socio-economic accessibility, within the Chamarajanagara District of Karnataka research area. The title of the study can therefore be described as, "***MEASURING ACCESSIBILITY OF HEALTHCARE SERVICES IN CHAMARAJANAGARA TALUK, KARNATAKA***"

1.4: Objectives

- To study the spatial distribution of health centers in the study area.
- To address disparities in healthcare access in the study area.
- To examine the Geographical Accessibility to Primary Health Centers.
- Identify the healthcare service shortage areas and to examine the site suitability of establishing of new health centers.

1.5: Research Question

Three study questions have been framed to analyze the approach as follows.

(a) What is the spatial trend among the district's medical blocks of existing health centers?

(b) How do the people in the study area connect the current health centers (time and distance)?

(c) Where are the best places to put an additional facility to fulfill unmet needs?

1.6: Methodology

From primary and secondary sources, the data for the study was obtained. Secondary data were collected from the District Health Office, Chamarajanagara District and Department of Census Karnataka, Bengaluru with regard to the number of public health centers such as District Hospital, Community Health Centers, Primary Health Centers and Sub- Centers. Each health center has also collected the requisite data relating to the health care system, health staff, and health infrastructure facilities. The location of established health centers was obtained using Garmin e-trex handheld GPS via a GPS survey. In addition, this information collected has been incorporated with ArcGIS 10.3 and the spatial data has been prepared. By applying the position quotient and the Lorenz curve, the spatial difference of health centers at the medical block level was calculated. In order to know whether the existing workforce is sufficient to provide service to the population of the district, the ratio between the population and the health workforce was carried out. Similarly, the population-infrastructure ratio was also measured.

In ArcGIS, the network analysis method was used to measure physical connectivity to all health facilities (primary health centers, neighborhood health centers and district hospitals) in terms of distance and time. The driving time was believed to be dependent on the vehicle traffic supposed to be on the respective roads, road hierarchy, surrounding land usage, road width, road nature, traffic bottle necks, etc. and does not take traffic signals into account due to the permission for emergency vehicles to pass off at traffic signal points. The driving time shall be applicable only under normal traffic conditions and shall not apply in situations where there are unforeseen circumstances of traffic delays or other obstacles such as tree falls, road accidents,

road blockades, etc. Variance analysis was used to assess the difference in both dimensions (time & distance) of accessibility between the hoblis of the Taluk. Time and distance accessibility was further overlaid to measure the overall accessibility.

A GIS tool called AccessMod provided by the World Health Organization was used to identify whether or not the population of the study region is served by existing health centers. It is the combination of four different models which are not only used to assess road-based accessibility to health centers, but also take into account the other landforms. Different parameters such as land use / land cover, topography, road network, physical obstacles, population coverage capability, spatial distribution of village settlements, spatial population distribution, position of established health facilities, travel scenario, travel path, etc. were modeled in the GIS domain to run the model. It explores the areas of health scarcity; the efficacy of established health centers; and also provides the necessary place for the establishment of new health centers.

1.7: Organization of Research

The systematic organization of the research is as under:

Chapter – 1: Introduction

The first chapter includes the introduction to research topic, Importance of the study Statement of the problem, Objectives, Methodology and Organization of research.

Chapter – 2: Review of Literature

This chapter deals with the review of literature. The review is on different aspects of research such as Distribution, Accessibility and Planning of health care centers.

Chapter – 3: Study Area

This chapter deals with the geographical background, physiography, climate,

demographic aspects and Socio-economic scenario of the study area.

Chapter – 4: Distribution of Health Centers

This chapter attempts to explain the Distribution of Healthcare Centers of the district. Location quotient, Lorenz curve and Average Nearest Neighbor Analysis have used to measure the unequal distribution of health centers among the medical blocks of the district. The ratio between population and health work force was carried out to know whether the existing workforce is sufficient to provide service to the population of the district. Similarly the ratio between population and infrastructure was also measured.

Chapter – 5: Accessibility to Health Centers

This chapter attempts to explain the accessibility to health centers of the district. Network analysis tool in ArcGIS have been used to measure the accessibility both in terms of distance and time to all health centers (Primary Health Centers, Community Health Centers and District Hospital). Analysis of variance has been used to measure the variation of accessibility among the medical blocks of the district in both the dimensions (time & distance). Time and distance accessibility was further overlaid to measure the overall accessibility.

Chapter – 7: Spatial Planning for health services.

The current chapter is framed to assess the efficiency of existing health centers in the study area. To identify, whether population of study area is covered or not by existing health centers, a GIS tool called AccessMod provided by World Health Organization was used. To run the model the input data (land use, road network, population coverage capacity, topography variation and location existing health centers) for the present study area was prepared. Through the model, the uncover population was identified and new health centers were suggested to cover the entire population of the district.

Chapter – 8: Summary Conclusion and suggestions

It is a concluding chapter, which provides a summary of the research besides presenting major findings of the study and it also provides the suggestions for improving the health service in the study area.

CHAPTER – 2

REVIEW OF LITERATURE

2.1: Introduction

A significant aspect of study in every area is the review of literature. The reasoning is that it allows the researcher to understand the pattern in a specific study and direct him in his studies on how to continue in his fields of research. The literature review provides an account of various studies performed in the subject of research encourages the identification of the research issue and the formulation of the objectives of the study and methodology.

There is ample literature on health services in the form of books, journals and studies. During the 1980's, medical geography flourished. Thus, from 1980 and up to the date, the analysis is made. The literature review references are mainly accessed from Bio-Med Central (http:/info.biomedcentral.com) where many articles have been accessed to gather health accessibility information.

The 'International Journal of Health Geographics' is the pioneering international journal in the field of health geography. Online open access journals have been widely used to access relevant research on accessibility to healthcare. Moreover, some of the works at global level were checked via the literatures available on the WHO website (www.who.com).

As the literature considered for review in the current research addresses various topics such as healthcare resources and services, the role of GIS in healthcare, distribution of healthcare facilities and accessibility.

The review has been carried out in the following themes,

- Healthcare Resources and Healthcare Services

- Geographic Information System and Healthcare
- Distribution and Accessibility

2.2: Healthcare Resources and Healthcare Services

Many of the Medical Geographers have been focusing on health-care tools, their distribution, programs, and health staff. Among them, Jayati Hazra (2002) clarified that health, healthcare and disease trends in Mizoram vary from those of the rest of India. Patil A.V (2002) attempted to objectively examine India's current state of health, with specific regard to a large rural population. The goal of the study is to holistically improve the prevailing situation, the issue of rural health at both the macro and micro levels, to ensure good health for the poorest of the population. He suggests a paradigm change from the existing 'biomedical model' to the 'socio-cultural model' needed to fulfill the rural population's needs. Shashidhar S.Mathapati (2002), tries to clarify the study area's environmental conditions to know its impact on the prevalence of different diseases. The research also aims to analyze healthcare facility usage trends to mitigate health issues. The research is restricted only to the centers of public health, major diseases and their causative factors. Nagarajan N.S. (2006), based on secondary data, analyzed the socioeconomic status, health education, existing policies and programs in Tamilnadu district of Kanyakumari. The study revealed that the socio-economic factors of the population play an important role in the health behavior of the people of the district of Kanyakumari and suggests more practical approaches in these areas to facilitate health education.

Roger Strasser (2003) addressed the major challenges of rural healthcare around the world, analyzed the problems and tried to identify the enormous obstacles facing improving people's health in rural and remote areas, and introduced a concrete action plan. The aim of

ensuring wellbeing for everyone in rural areas can be accomplished by the concerted efforts of working people in rural areas around the world, such as physicians, nurses and other health workers. Damodar Panda (2006) investigated how the current food habit is imbalanced in terms of quality and quantity, resulting in nutritional deficiencies in the field of research. The research is primarily focused on the primary data obtained through random sampling, questionnaire methods are used for both qualitative and quantitative analysis, food and nutrition deficiencies have been assessed.

Lakshmi.K (2009) studied 'Rural Healthcare Access' in District Madurai rural areas. The study aims to define the difference between accessibility and quality health care standards in rural areas. It describes the areas facing challenges and proposes that primary health care be strengthened. Dalal K & Dawad S (2009) explores the views of women on their reasons for not using suitable public health facilities in India. The author explains that in reducing maternal mortality and poverty, improved quality of care is important. Ahmad Ateeque, et al (2009), address the pattern of distribution of health facilities and the level of development of educational facilities in order to establish a micro-regional strategy for increased access to health facilities. Diagnostic planning based on qualitative and quantitative approaches to achieve the aim of achieving sustainable regional growth has been proposed. James M.Tien, et al (2009), addressed that healthcare can be viewed as a mixture or recombination of three essential components: Individuals, Method and Goods. In essence, it is a device whose purpose is to increase its efficiency and efficiency in order to improve health. Combination takes place over the spatial, temporal, functional and organizational aspects. So in such service systems as healthcare, they consider that they are indeed complex.

Dhanashri. S.Shinde (2010) analyzed the spatial distribution of different health facilities and used the ranking coefficient approach to formulate the Composite Health Facility Index (CHFI). Accessibility and efficacy of existing health facilities have been assessed while potential plans have been drawn up for the construction of health facilities in the region. In their research, Meenakshi Gautham et al (2011) found that most rural people seek first-class curative health care close to home, and pay for a composite convenient consulting service – cum-dispensing of medicines. In his paper, Chandrakumar Sedamkar (2011) said that health is an important tool for social and economic growth and can play a very important role in creating a new world. The research focused on exploring the state of health among the elderly and how they handle health. In his paper, Naresh Kumar attempted to investigate the availability, geographical accessibility and efficiency of primary health centers and private registered medical practitioners in 920 villages and 14 towns in two districts (Rohtak and Bhiwani, located in the north-western part of India) for three periods in 1981, 1991 and 1996.

2.3: Geographic Information System and Healthcare

Charles M. Croner (1996) clarified that GPS, topology, planner and surface measurements are fundamental GIS properties that are valuable tools to define or locate the disease center and help to monitor and avoid diseases by protecting public health systems. Francisco Escobar, et al (1997), offered a brief description of the current state of GIS applications in Australia's healthcare sector. They also focused on 'GIS for General Practice' and presented the Divisions of General Practice in order to locate the spatial field of operation of the project. The research was based on both primary and secondary knowledge by Abdul Kader A. Murad (2001). He made an attempt in this paper to identify available healthcare (government hospitals) and spatial disease distribution using GIS, and discusses accessibility, healthcare

utilisation in Jeddah City Saudi Arabia. He also addressed the spatial changes in health status and defined a set of criteria for new hospital locations to be planned. Johnson. C.P & Jasmin Johnson (2001), attempted to clarify the mapping of Public Health Services, particular illnesses and other health incidents in relation to their surroundings and current health and social infrastructure, this information provides a powerful tool for tracking and controlling epidemics when mapped together. GIS facilitates interactive queries of the information in the map, table or graph. This allows for complex maps published on the internet to aid patients to be automatically represented on the maps. GIS provides aerial / satellite images to allow easy integration of information such as temperature, soil types and land use, and to evaluate spatial associations between potential risk factors and disease incidence.

Thomas C.Ricketts (2003) claims that the GIS is not the full solution for understanding the spread of diseases and public health issues, but it is an significant way of illuminating how human beings communicate with or establish health in their environment. Sara L.McLafferty (2003), in 4 pages, reviewed the recent literature on the application of GIS in healthcare. GIS study on the measurement of healthcare needs is addressed in the first section. The second section discusses how GIS is used to research regional access to health care, and to explain gaps in access between demographic groups. The third section focuses on usage, illustrating the use of GIS in the study of regional differences in the use of healthcare. The final section discusses the use of GIS in health care assessment and preparation. There is also discussion of location-allocation modeling and spatial decision support systems. Ellen K. Cromley (2003) describes and summarizes selected research, mainly in the United States, using GIS and remote sensing for disease investigations. He clarified the distribution of disease agents, the exposure to disease agents and the vital relation with the environment for the creation of disease surveillance systems

using GIS and RS. Shankar. K.N and Sathish Selvakumar (2003), introduce a custom GIS application that would be an interactive spatial analysis tool that would allow health officers to re-distribute and re-locate health jurisdictions for the efficient use of health infrastructures. Phase-1 operation was to establish the health jurisdiction for the entire state of Karnataka, establish a framework and send data to each District Health Office to collect PHC and Sub-Centre data. The technique was carried out in two phases. This list was mapped to the village boundary, and all jurisdictions of PHC & SC was compiled. Phase 2 operation creates a custom GIS program unique to the Department of Health's needs. It is possible to prepare and distribute for input and approval, based on the relevant specification document. The outcome of this comprehensive GIS program with specialized resources is to care for the health department's needs.

In exploring the relationship between geographic access, usage, efficiency and health outcomes, Gary Higgs (2004) demonstrated the use of GIS-based interventions. It examined the variety of approaches taken by him to test the relative importance of geographical factors which could influence access. The research objectively assesses the situation regarding the usage of such interventions in a wide variety of studies on accessibility. Finally, he recommended regions where there is a strong demand for health care services.

Santandu Dutta (2005) attempted to research malaria using remote sensing and GIS in the Jalpaiguri district and also investigated the relationship with the study area's socio-economic situation. The work is useful in the manipulation and interpretation of the areas to be affected. Sabasen. S and Raju K.H.K (2005) explored the concepts underlying the dynamics of disease transmission and reported that the prediction of disease incidence is possible based on environmental factors and remote sensing data based on satellites. The study also confined the

importance of modern tools such as remote sensing; Geographic Information System (GIS) is handy for addressing disease detection, control, monitoring and evaluation issues. The rural health information system envisaged for the GIS domain demonstrates how it essentially promotes resource use, disease prevention and health promotion, works towards overall rural development, and thus ensures the sustainability of the program at all levels.

Sumi Singh (2006), based on the management of medical services and the provision of adequate healthcare with optimal use of available scarce resources in remote areas, the incorporation of multiple data sets with spatial and statistical attributes to forecast the areas affected and to produce a model for disease control and to create models for further study. This allowed the current shortcomings of medical facilities and equipment to be recognized and led to a solution with the help of GIS to resolve this contemporary data. This has also made it possible to merge contemporary data with spatial data to provide better medical services in rural and outreach areas for the vulnerable. Mesgari. M.S & Masoomi. Z (2008) tried to research and analyzes the Public Health applications of GIS. The restrictions and difficulties of the use of GIS in decision-making for the management of public health in special circumstances in Iran have been discussed and some suggestions are being made to address these problems.

Ann Graves (2009) sought to recognize the need for policies in the United States to increase access to healthcare services and to encourage change in health outcomes. Increasing the quality of life and removing health inequalities (social and political issues) in access to healthcare and health results. He also uses the Andersen Behavioral Health Services model which provides one solution to accessing health services. Rajiv Sharma, et al (2009) examined the distribution and accessibility of healthcare facilities in a serviceable region with proximity to their respective villages using GIS and also apply online healthcare applications to obtain

accurate information to support decision-making activities such as infrastructure planning, creating new facilities based on gap analysis that can be defined on the basis of the spatial distribution of existing facilities.

Two potential methods for assessing and evaluating physical accessibility to health facilities were developed by Michael Black et al, using multiple layers of knowledge combined into a GIS. These approaches are introduced and compared in relation to a specific issue of public health in Central America; they chose only PHC to define issues with accessibility using GIS. This leads to effective health planning and policy development by supplying vulnerable communities with health services. Ankita Misra, et al, analyses the distribution, availability and use of healthcare facilities in Pune District, of hospitals and diseases using GIS. They also suggested suitable locations for the establishment of new hospitals in the district of Pune.

Anuj Bariar, et al, focused on developing the village-level spatial data infrastructure for part of the Allahabad district of the state of Uttar Pradesh under the GIS setting. It is useful in planning, rural infrastructure development, administration, resource mobilization and micro level planning decision making. Luo Wei and Wang Fahui synthesized two GIS-based accessibility interventions into one framework work and applied the methods for evaluating primary health care spatial accessibility in the ten-country area of Chicago. The Floating Catchment Area (FCA) approach determines the physicians' service area by their encompassing demands. The gravity-based approach finds a local physician to be more available than a remote physician, and discounts the availability of a physician based on gravity capacity. The former is a particular case of the latter here. Based on the 2000 census and primary physician data, this paper analyses the variance in spatial accessibility to primary care in the Chicago area, and analyses the sensitivity of results by experimenting with threshold travel time ranges is an FCA method and travel

friction co-efficient in the gravity model.

2.4: Distribution and Accessibility

The healthcare inequalities arise due to hitches in ideal healthcare functionalities such as availability, accessibility and affordability, (Steinwachs & Hughes 2008). The distribution of health services, population and transport infrastructure contributes to health center access gaps (Delamater et al., 2012). The most important features influencing health status and results include distance between the geographic regions of the population and health care services, as well as the travel time required to access the health care center. The most important features influencing health status and results include distance between the geographic regions of the population and health care services, as well as the travel time required to access the health care center. The aim of their research was to identify hot spots of disadvantaged communities burdened by the right kind of health services due to geographical accessibility. Three types of critical health care facilities have been evaluated for geographical accessibility: obstetrician / gynecology (women of childbearing age); pediatrics (children) and Trauma / Burn Centers (general population). Finally, they established hotspots of vulnerable populations living outside of service areas, with rural regions and pregnant women bearing much of the health burden due to geographic inaccessibility. Health care is the basic care given at the community level to the communities and targets improved health outcomes and greater health equity. The key to forming healthier societies and improving and sustaining people's health is primary health care.

The quality of health care in rural areas with primarily low income and minority communities depends largely on geographic access and the distance to health care facilities is highly responsive when making health care choices. The ability to obtain health care services that meet the population's health requirements is known as geographical accessibility. It means

that a group has accessibility to health care if the services meet unique features such as geographic location; affordability that suits patient needs (Levesque, 2013). GIS offers a broad variety of methods and roles used for the preparation of health services. Murad (2011) carried out a survey-based analysis on the demand and availability of health services in Jeddah town of the Kingdom of Saudi Arabia in this regard. The author applied the GIS for the exploration of accessibility to health centres covering three key analytical issues; i.e.; 1) health care provision; 2) location and features; 3) extent of accessibility to health services. The growth and extent of health centres was delineated on the basis of the above-mentioned analytical issues.

An imbalance in accessibility to health care depends on a number of factors that make it necessary to research the essence of the factors (social , geographical, or economic lines) that affect access inequalities (Ricketts et al., 2001). Hyndman et al. (2001) conducted the research in Perth, Australia, examining that the relationships between social disadvantages and provision of quality and quantities of General Practice services, and regional access to healthcare services is relatively similar across socio-economic classes. However, residents of poor communities are struggling to get evening and same-day appointments. They conclude that services were available but that some underprivileged communities had more travel time and insufficient quality of services. Jamtsho and Corner (2014) conducted their Bhutan study for the evaluation of health care center supply, demand and spatial arrangement. Accessibility was calculated based on the ratio of population to the Euclidean distance and health facilities. The goal of the study was to quantify the ratio of population to health facilities for calculating spatial accessibility. The study showed that health care system inequalities with only few percent of the population benefiting from decent health services.

In order to assess spatial accessibility to health centers using GIS, a variety of studies

have been carried out (Higgs and White, 2000; Witten et al., 2003). Quah (1977) revealed numerous measures such as a region's health status, a good number of health centers, fair distribution of health centers and the absence of barriers significantly influenced accessibility to health care facilities and also showed different dimensions of accessibility. In order to underline the impact of distance on physical accessibility to health services, various authors used various methods and techniques (Joseph and Bantock 1984). The research on the distribution of various types of health care facilities in Istanbul was conducted by Dokmeci and Ozus (2004). Their research found that the allocation of health care services is influenced by a society's population income and literacy percentage.

Brabyn and Skelly (2002), consider an acceptable range of one hour since an hour is a maximum for which ambulance driver’s talk. They also warn that the cost of visiting a hospital is high for people who have to travel for more than one hour. The use (GIS) of various dimensions of the healthcare system has resulted in a variety of studies dealing with the implementation of access measures to healthcare facilities (Higgs 2004). In the literature of health service research (Gulliford and Morgan 2003), accessibility has been described in several ways. As per Andersen and Aday (1975), religious values and perceptions affect the accessibility of health care in various cultural and geographical settings. The measure typically assumes that, given the full range of the service provided at a facility and assuming that each member of the community is a possible user of the service, the physical accessibility pattern would depend only on the relative position of the community and the service facilities recognizes Khan (1992), Joseph and Bantock (1982)

The usage or actual entry into the system of services depends on the obstacles and facilitators of both the service system and the potential users. Previous research in the health

sector explored differences in the position of, for example, surgeon surgery at a number of spatial scales in order to explore possible inequalities in the relative accessibility of such facilities (Knox 1978; 1979). In their study, Joseph and Phillips (1984) used the regional availability factor to analyze demand-related spatial health pattern services. The ratio of population to health work force was the key factor for estimating the spatial trend considered. One of the recent developments, such as the use of multiple health center buffer study, is to resolve the population constraint of area-based doctors (Luo 2004). Hewko et al., (2002) notes that the Floating Catchment Area (FCA) method can be useful in overcoming the presumption of cross-border method provided a person has access to detailed address. Radke and Mu (2000) and Wang and Luo (2005), note that a two-step approach can be used to boost the floating catchment area. In the first approach the health facilities catchment area is assessed based on travel time and in the second approach the catchment is measured based on travel time across each demand center.

Wachs and Kumagai (1973) performed the research in North California and demonstrated the use of GIS network analysis to estimate the accessibility of travel time. Their research showed the value of the model of location allocation to transfer the patients to the nearest health facility. Lin, (2003) calculated accessibility to the health facility on the basis of travel time and revealed the inverse relationship between people 's accessibility and distance to the health facility which, in their opinion, was heavily influenced by income factor. There has been an increase in the use of GIS in developing countries to highlight the possible accessibility of health centers in developed countries and to create new health facilities in relation to malaria (Noor et al., 2003; Schellenberg et al., 1998), tuberculosis (Tanser and Wilkinson 1999), access to HIV care (Tanser et al., 2000), public mental health planning and cancer resources (Bhana and Pillay 1998;

Oppong and Hodgson 1994). Scott et al., (2002) carried out their analysis to demonstrate the shortcomings in South Africa of existing health care facilities for cancer treatment. Their study found that weak sectors in terms of connectivity to such facilities are worst-hit regions. They also showed that the use of GIS can be very useful for the construction of new health facilities in poor sectors.

In their research on Belgium, Van der Heyden et al., (2003) revealed that proximity to health care centers differs with society's socioeconomic status. In his research, Gulliford (2002) stressed the relationship between the availability of physicians at the health care center, the mortality rate and admission to the hospital. The disparity in accessibility to cancer centers in South East England has probably been due to the poor surviving rate of patients with lung cancer (Jack et al., 2003). Pitchforth et al., (2002), however, notes that GIS techniques need to be used to track accessibility to healthcare specialists. As primary health centers that provide basic health services and hospitals that provide advanced treatment, healthcare facilities are predominantly of two kinds and it is therefore important to provide health services at a given location at the time of need (Jordan et al., 2004). Besides this, there are some limitations such as cost, time, social issues and even the psychological stress that affects the accessibility to health centers Roovali and Kiivet 2006). A region's proximity to health care is closely determined by demographic and socio-economic characters (Field et al., 2004). Penchansky and Thomas (1981) suggest that access is most commonly seen as a notion that somehow relates to the capacity or desire of consumers to join the health care system and describes access as a term that reflects the degree of fit between customers and the system.

2.5: Conclusion

In the literature review, the two wide areas of focus are (a) healthcare delivery and (b) accessibility, which not only promote 'accessibility' in particular, but also 'healthcare distribution' in general. Indeed, the analysis and evaluation provided for a variety of different roles and good case studies in each case, and a study was performed on four different themes related to the current research in this regard.

The new subject that flourished in the 1980's is healthcare geography. Several geographers have been active in various fields of healthcare planning. Our experience, however, shows that all is not well with the delivery and accessibility of healthcare, there is a need to build awareness of fair healthcare services for delivery. Studies have shown that the distribution of health services and socio-economic factors that impact access to health centers is unequal. Reasonable measures for the equitable distribution of healthcare services and better accessibility measures in relation to time and distance have been identified and suggested by some researchers.

CHAPTER- 3

STUDY AREA - CHAMARAJANAGARA TALUK

3.1 Introduction:

The southern-most district in the state of Karnataka is Chamarajanagara. It was carved in the year 1998 out of the original larger Mysore District. The headquarters of this district is Chamarajanagara town. The district of Chamarajanagara consists of 4 taluks with 16 hoblis: Chamarajanagara, Gundlupete, Kollegala and Yelanduru. With an area of 2786Sq.kms, Kollegala is the largest taluk, while Yelanduru is the smallest with an area of around 266 Sq.kms. There are 512 villages, 430 of which are inhabited and 82 of which are uninhabited.

Chamarajanagara also known as ARIKUTARA or ARIKOOTARA was also known as Wodeyanooru. In Chamarajanagara, in 1774, the 9th Chamaraja Wodeyar was born. JANANA MANTAP was constructed at the place of his birth in his memory and the government declared it a Heritage Structure. The Ganga Dynasty, Chalukya, Cholas, Hoysala, Vijayanagar Rulers, Mysore Wodeyars, and Ummathur Nandayal Kalale leaders ruled the area. All of these separate dynasties ruled until 1950, from the 8th century to the 20th century.

In the year 1818, Chamaraja Wodeyar's son Mummadi Krishna raja Wodeyar (1794-1868 Christian era) remodelled the town and renamed it Chamarajanagara. He founded the Temple of Chamarajeshwara in 1826. The temple 's car festival of presiding deity is conducted with a great deal of fan fair, according to the Hindu calendar in Ashada Masam, where newly married couples come and give prayers to the deity for the achievement of their goals. Bhujangeshwara, Veerabhadrana Gudi, Kadu Narayana Swamy, Chowdeshwari, Kannikaparameshwari etc. are the other temples located within Chamarajanagara Town, close to Marigudi Temple private bus stand, Sampige Road Srikanteshwara, Manteswamy Road Santhemarahalli and Puttammanni

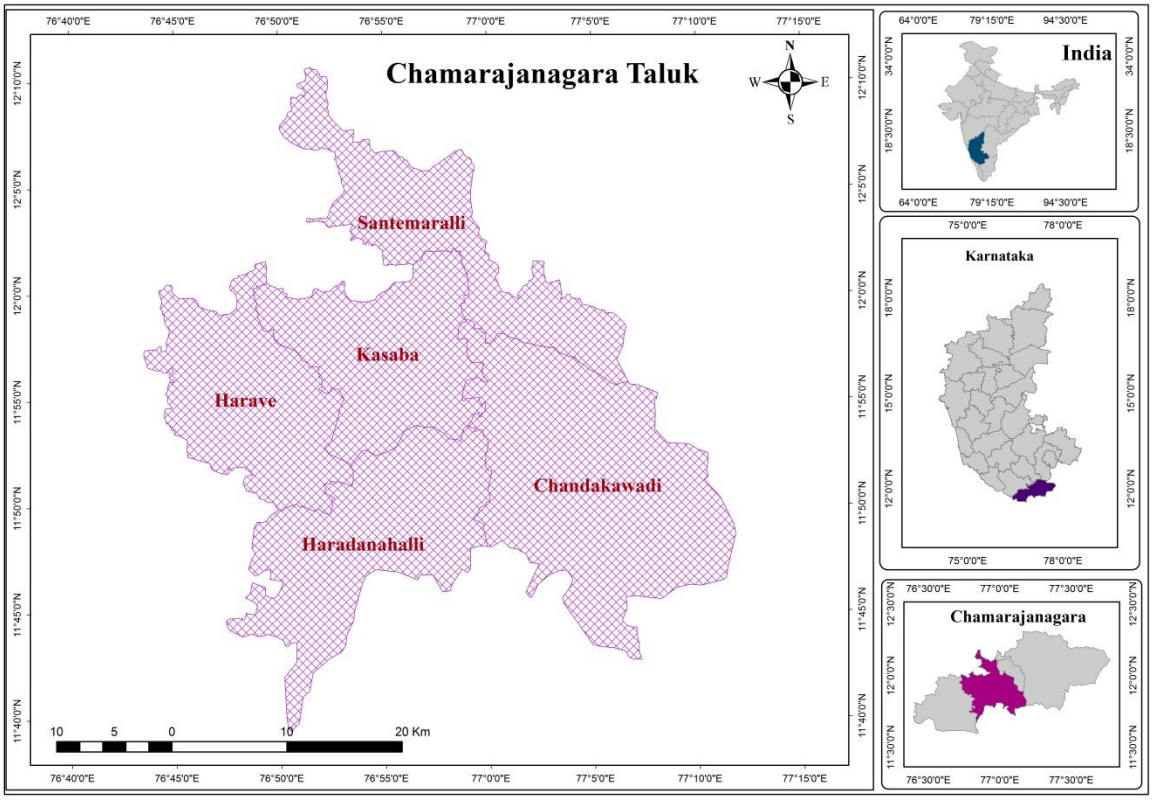
Temple are of particular importance and very old is the Parshwanath Basadi. There is a hill containing the temple of Karivardharajaswamy at the southern end of the town.

The Temple of Rameshvara is situated 25 km from the village of Narasamangala a town in Chamarajanagar. The temple of Rameshwara was built during the Ganga period and can be assigned to the 19th century. Hoysala Viraballala III and some grants made by him to the god Ramanathadeva of Narasamangala are alluded to by an inscription carved on two slabs south of the temple. A spacious Garbhagriha, a narrow Ardhamantapa, and Mahamantapa are in the temple. A remarkable development with a brick and stucco vimana of great beauty and artistic merit, 11 m, is the Sikhara over the Garbhagriha. High above the lofty Adhishthana Stone, 2 m. Elevated.

It is the Vimana Tritala Dravida. The ceiling of the Navaranga has Nataraja surrounded by Dikpalas. One of the striking pictures here is that of a state-seated king and his queen standing next to him. The life-size Saptamatrika images are positioned behind the temple in a hall. For their workmanship, they are exquisitely carved, elegant and notable.

3.2 Location, Extent and Administrative Units:

Chamarajanagara Taluk is one of the Chamarajanagara district's four taluks. Chamarajanagara Taluk is part of a semi-arid climate zone. In addition to being a cultural unit between 76°.40 'and 77°.15' east and 11°.40 'and 12°.10' north latitudes, the research region forms a separate land unit. It has an elevation of 662 metres on average. It has an area of 1235.90 Sq. Kms. It includes 190 villages covered by the Indian Toposheet Nos. 57D/12, 57D/16, 57H/4, 58A/9, 58A/13, 58A/14, 58E/1, 58E/2, 58E/5 on a scale of 1:50,000. The average annual rainfall on the taluk is around 696 mm.



Map 3.1

With a mean maximum temperature of 34ºC and a mean minimum temperature of 16.4ºC, Chamarajanagara taluk enjoys a healthy climate. This taluk does not have any big river drainage. This area is, however, drained by Suvarnavathi and Chikkahole, which are tributaries of the Cauvery River bordering the Chamarajanagara District's Kollegal taluk. An undulating plain is the topography of the study region, underlain by hard rock consisting mostly peninsular gneiss and Chamockites. March to May is the monsoon seasons, and June to September is the summer months. The post-monsoon season is from October to December, and the winter months are from January to February.

3.3 Physiography:

Physiographically, the district of Chamarajanagara is an undulating table land with granite rocks creating an irregular interval. The district's general elevation ranges from 700-900

meters above the mean sea level. The high mountain ranges in the district start from the Nilgiris along the Southern Borders and extend north-west and north-east along the Western Ghats and between them the Chamarajanagara Plateau. It is a peneplane with an average height of more than 760 metres. Except in the north, the district is almost surrounded by western and Eastern Ghats, some of which are more than 1,200 metres above sea level. The key hills are Biligiri Rangana Hills (1687 metres), Kattari Betta (1816 metres), Honnameti Betta (1773.27 metres), Ponnachi Betta (1490 metres), Honnattikal Betta (1451 metres), Ettina Betta (1363 metres) and Punajanur Betta (1252 metres) which form part of the Eastern Ghats.

The Kattari Betta is the tallest of the hills above. Malai Mahadeshwara Hills from a hill about 976 metres above sea level. Gopalaswamy Betta is a lofty hill that is highly picturesque in nature, rising to a height of 1468 metres above sea level. It is named Kamaladri and Dakshina Govardhanagiri in traditional writings. It is usually shrouded in clouds and fog; hence, the name Himvad Gopalaswamy Betta has been more aptly coined to this hillock.

3.4 Geology:

Geologically, the district consists predominantly of Precambrian-age igneous and metamorphic rocks, either exposed to the surface are covered with thin residual mantle and transported soil. The district's rock formation falls into two categories, the Charnokites series, and the granite gneiss or granite genesis. The Charnokites series of rocks consist of a fairly large area of the district, particularly along the south-eastern border of Yelanduru taluk and Biligiri Rangana hills. Granite gneiss with thin bed lenses and elongated runs of various horuoblendic rocks, pyroxenites, and chromite and magnesite-containing purities are the intervening land. In Kollegala taluk, which is surrounded by the Hills of Charnokites, the southern termination of the

linear closet granite batholiths takes place. There are a good number of Dolerites in the Gundlupete taluk.

3.5 Drainage System:

Suvarnavathi:

In the south-eastern part of the district near the Gejjalahatti valley of Chamarajanagara taluk, the border area between Karnataka and Tamilnadu states, Suvarnavathi or Honnuhole rises. It flows through the Chamarajanagara and Yelandur taluks to the north. It has a catchment area of approximately 187 kms and a total course of around 88 km in the district. Two streams viz., Neredurgihalla originating from the estate of Attikani and Araikadihalla at Dimbam, the former passing for about 19 km while the latter formed as Suvarnavathi for about 32 km before joining together near Budipadaga. After flowing for a further distance of 11 km, this river is joined by another tributary, the Chikkahole, and at Kukkur it eventually joins the Cauvery on the right.

The Chikkahole originates south of Chamarajanagara near the state border with Tamilnadu in the Hasanur ghat range. A dam was installed 12 km from Attigulipura in Chamarajanagara taluk across this tributary to feed irrigation channels and tanks.

The Pallar:

The pallar river is a tributary of the Cauvery river, and for around 45kms it forms the shared border between the states of Karnataka and Tamilnadu in the districts of Chamarajanagara and Udagamandalam.

The Moyar:

The Moyar River forms a shared border for around 22 kms between the Chamarajanagara and Udagamandalam districts of the states of Karnataka and Tamilnadu. A picturesque gorge known as 'Mysore ditch' cuts into the Moyar River, which is about 260 metres long, creating one of the most stunning landscape features overlooking the famous Nilgiri mountains. From where the Kekkanahalla joins the Moyar River to the place where the Sikattihalla crosses the Moyar River, it stretches all along the southern frontier of Chamarajanagara.

The Udutore Halla:

The Udutore halla is a tributary to the Tattehalla, which in turn converges on the right side of the river Cauvery. With a catchment area of about 790sq.kms, it has a total course of around 80 km.

3.6 Climate:

On the whole, the climate of the Chamarajanagara taluk is good. The taluk enjoys cool and fair temperatures and shares the state as a whole's large climatic pattern, although there are some distinctive climatic characteristics. The climate of the district can be described as a form of monsoon that is essentially tropical, a result of the interplay of the two opposing air masses of the monsoons of the south-west and north-east. Summers are lazily warm and winters are bracingly cold in much of the district. Chamarajanagara taluk is usually blessed with a nice or safe climatic state. The following four seasons usually refer to the Chamarajanagara district, depending on the prevailing climatic conditions.

1. Warm weather.
2. South-west mansoon.

3. North-east mansoon.

4. Cool weather.

Warm weather: In the month of March, warm weather seasons begin and increase their intensity towards the end of May. The temperature varies from 19.7 ° C-35.1 ° C during this season. The surface of the soil is very hot and there is a wide variety of temperature differences between day and night. Occasionally, however, there is relief from pre-monsoon thunder storms.

South-west monsoon: At the end of May or early June, the South-west monsoon sets in and lasts until the end of September at some intervals. It is the state's dominant rainy season, but the district does not receive adequate rainfall from the south-western monsoon. The average annual rainfall is approximately 760 mm over a seven-month cycle, from the latter half of April to October. The range of rainfall is between 600 mm and 1100 mm.

North-east monsoon: In October, the north-east monsoon starts and ends by the end of December. The monsoon winds bring more rain to the district's eastern portions. The monsoon period is shorter and the rain intensity is more limited to a smaller region of the district.

Cold weather: The cool weather season starts in early December and ends in February. The weather, except in the catchment areas of the rivers, is comparatively dry during this season. In day and night temperatures, there are wide variations. In this season, the lowest temperature is recorded, but the average temperature does not go below 16.5° C. January is a typical cold month, with the lowest temperature recorded in a year. The temperature varies from 16.1° C to 13.3° C during this season (Nov-Feb).

Temperature: The socio-economic practises of the citizens in an area are greatly influenced by temperature. The district enjoys a cool and fair temperature in general. There is a continuous

temperature increase in the period from March to May. With an average daily maximum of 34.5° C and a daily minimum of 21.1° C, April is the warmest month. During the summer, daily temperatures may reach 39° C on normal days. When thunder showers occur during April and May, which is before the monsoon season, there will be welcome relief from the sun. During the south-west monsoon season, the daily temperature drops significantly and the weather is good. Both day and night temperatures fall after mid-November. With a mean daily maximum temperature of 11° C, January is the coldest month. The minimum temperature will go below 11° C on some days during the time from November to January. As of April 2008, the highest maximum temperature recorded in the Chamarajanagara district was 36.93°.

Humidity: During the South-west monsoon season, relative humidity is usually high. Relative humidity throughout the year is around 70 percent and more throughout the morning, while humidity is comparatively poor throughout the afternoons, except during the south-western monsoon season. The time between January and April is the driest part of the year, with a relative humidity of about 30% and even lower in the afternoon.

Rainfall: The difference in annual rainfall from year to year over the 100-year period from 1901 to 2000 is not important. The district's usual annual rainfall is 751 mm, 114 villages receive more than 960 mm of rainfall and 199 villages receive between 720 and 750 mm out of the total of 446 villages. Less than 550 mm is granted to the remaining villages. On 17 October 1916, the heaviest rainfall in 24 hours recorded at any station in the district was 205.5 mm at Chamarajanagara. On average, there are 45 rainy days per year (day with a precipitation of 2.5 mm or more).

Table 3.1: Month wise Avegare Temperature (°C) Rainfall (mm) Relative Humidity (Rh%)

Months	Temperature		Average monthly	Humidity	
	max	Min	rainfall (in mm)	0830Hrs	1730Hrs
January	32.2	36.0	0.3	82	44
February	32.5	17.53	23.2	83	37
March	36.8	19.66	28.7	83	35
April	34.8	27.63	124.1	91	34
May	33.56	21.63	94.6	99.9	39
June	31.7	18.2	61.5	91.0	39
July	31.8	21.3	47.0	91.0	43
August	31.9	21.3	92.9	91.0	57
September	32.53	20.16	26.6	83	48
October	30.86	21.36	136.0	99.9	64
November	29.6	18.36	116.6	99.9	51
December	29.8	17.3	7.3	99.9	43

Source: Indian Meterorological Department.

3.7 Natural Vegatation:

In terms of forest area, Chamarajanagara district is one of the well-known areas of Karanataka state and has 7.58 percent of the state's total forest area. Of the total geographical area of 569901 hectares, as per the 2011 census, forests constitute 48.36 percent of the area of the district. There are two types of forests in the district of Chamarajanagara and they are moist deciduous where the precipitation is 900-1100 mm and dry deciduous where the precipitation is 700-900 mm.

Two sub-divisions, namely Kollegala and chamarajanagara, have divided the forest area of the district. Sandalwood is the state 's richest forest resource. In the district, the forest belt

starts in the western part of the Gundlupet taluk, stretches along the boundaries of the states of Kerala and Tamilnadu and ends in the south and east. Gundlupet taluk goes on to the thickest and richest forest areas. Teak, honne, rosewood, dindiga, eucalyptus and sandalwood are the principal spices of trees in the area. The resemblances of evergreen forests are restricted only in the high altitude hilly regions. In Kollegala taluk, with almost 70 percent of the district, the area under forest cover is high and Gundlupet taluk falls next with 16.27 percent , followed by Chamarajanagar and Yelanduru taluks with 9.76 and 3.84 percent , respectively. The district 's main forest produce consists of teak, sandalwood, matchwood and building materials, the region's forests indirectly confer different ecological benefits.

3.8 Agriculture:

The district's south-western and southern parts begin at the edge of western ghats, well equipped with adequate rainfall and known for producing a variety of reunified crops. Around 34.7 percent of the main workers are essentially engaged in cultivation in addition to reunified cultivation, the canal network work of Suvarnavathi and Chikkahole and their tributaries and countless tanks also encourage intensive agriculture. Around 33 percent of the overall geographical area is the net area sown in the district.

Land use and crop pattern: the net area sown in the district during 1997-98 was 178797 hectares and increased to 186616 hectares during the year 2009-10. This is directly linked to the rise in irrigation. During 1997-98, approximately 4.28 percent of the land area was under non-agricultural use and it rose to 4.29 percent in 2009-10 due to the successful implementation of various rural development activities under Integrated Rural Development Programmers (IRDP). During 2009-10, about 48 percent of the geographical area was forested. In the same year, the region and permanent pasture and various tree crops and forests were 4 percent and 1 percent.

Kollegala taluk stands first with Yelanduru at the bottom of the list in terms of forest coverage. The forested area ranges from 193259 hectares in Kollegala to 10589 hectares in Yelanduru.

In Gundlupet taluk, the net area sown was very high with 46.62 percent in 1997-98, 44 .. 31 percent in Chamarajanagara taluk, followed by 38.59 percent in Yelanduru was. With 17.31 percent, the lowest net area sown was in Kollegala taluk. In Chamarajanagar taluk, the cultivable wasteland is more with 2.37 percent, in Kollegala Gundlupet with 2.32 percent and 0.65 percennt, and in Yelanduru taluk the lowest with 0.55 percent, which is comparatively smaller in size.

Table 3.2: General Land Use

Types of Major Land Use	**Area in Hectares**	**% to Total Area**
Forest	275610	48%
Non-Agricultural	24606	4%
Barren	21434	4%
Cultivable-Waste	7637	1%
Permanent Pasture	22750	4%
Trees & Groves	4741	1%
Current	10708	2%
Others	15799	3%
Net Area Sown	186616	33%
Total	**569901**	**100%**

Sources: District Hand Book, 2009-10

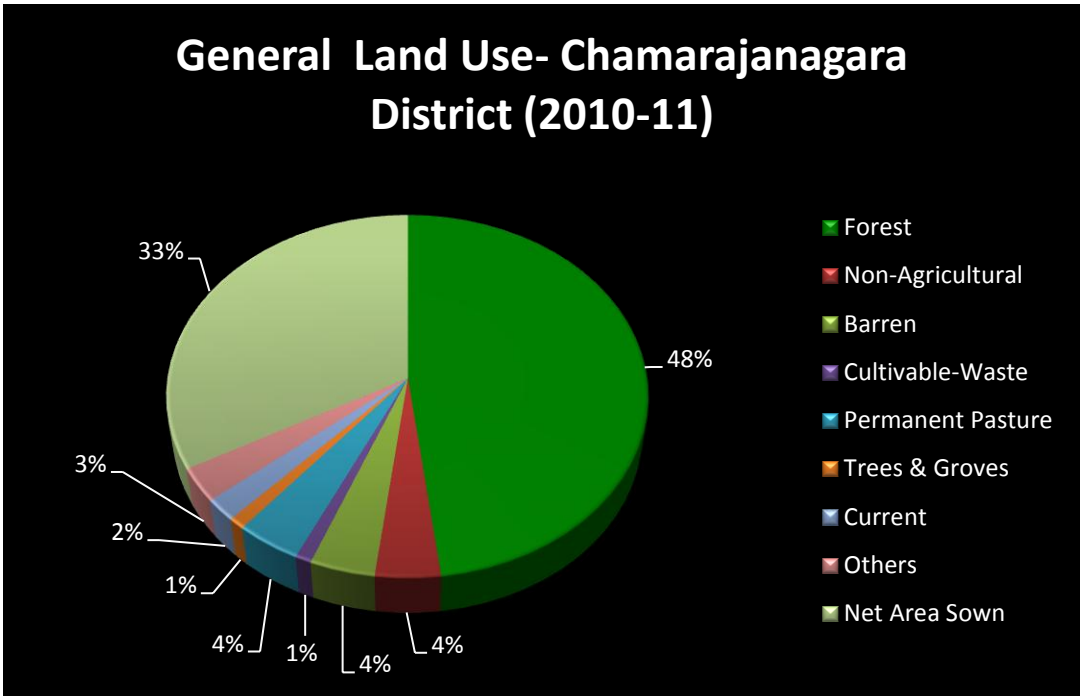


Fig: 3.1

3.8.1: Soils

The red-loam, sandy loam and black cotton soil can be broadly defined as the soils of the district. There is a deep red loam base sometimes interspersed with black soil in the taluk of camarajanagar, Gundlupet and Kollegala. From the granites and gneisses, the red sandy loamy boils are derived. Many parts of Yelanduru taluk are covered with black cotton soil and occasional alluvial soil that is shallow to deep well drained and does not contain lime lodules, with strong water holding capacity for a longer time, the black soils are 1 to 1.5 metres deep.

3.9: Irrigation and Water Resources

The district of Chamarajanagara has an irrigation capacity of about 19 percent of the total cultivated land. Nearly 26.48 per cent of this region is irrigated by canals. However, among the taluks of the district, the share of irrigated land varies substantially. In irrigation, much significance was granted to the eastern dry belt taluks. Thus, the spread of irrigated land in Kollegala is 37.49 percent. In Yelanduru, 51,33 percent, and in Chamarajanagar taluk, 20,57

percent. The western transitional taluk belt, namely Gundlupet, has 10% of its total irrigated land. The percentage of the area under irrigation was given as a figure during 1997-98. The western portion of the region is mainly rainfed, while irrigation is mainly in the dry belt.

3.10 Demographic Characteristics:

As per 2011 census, the population of the district is 1.20 million where 0.84 million rural and 0.17million urban populations in 2011. The district has 2.96 percent of state area and ranked 17^{th} in area and 26^{th} in population among districts of the state. It consists of 1.82 percent of the total population of the state, and it was 1.96 percent in 2001. In an area which constitutes 2.96 percent of the area of the state. The density of the population in the district is 189 per sq. kms.

The total geographical area of Chamarajanagara taluk is 1226.67 Square kilometres. It has one town, 5 hoblis with 197 villages. The five hoblis are: Harave Hobli, Kasaba Hobli, Haradanahalli Hobli, Santhemaralli Hobli and Chandakawadi Hobli. As per 2011 census, the population of the taluk 3,57,799 highest population in Kasaba Hobli with 1,25,259 and lowest in Harave Hobli 48,092.

3.11 Industry:

The district is blessed with abundant metallic and non-metallic mineral resources. It has vast black granite reserves with export potential. Therefore, they provide rural populations with employment opportunities. Information technology & bio-technology, textiles, agro-based, tourism and granite industries are the primary target sectors. The district has 4 major factories. Pioneer Power Corporation Limited and Shree Mahadeshwara Sugars are the most frequently defined units. There are 8127 small-scale businesses scattered throughout this district.

3.12 Educational Services:

The district of Chamarajanagara does not have adequate educational facilities. There are 907 primary schools, 108 middle schools, 54 pre-university colleges, 15 degree colleges, and a polytechnical and one engineering college in this district. The district has 446 revenue villages; the requirement is that, in order to provide basic literacy, at least a high school should be located in each village. Middle schools and high schools are only accessible to meet 25% of the requirements of the population, but 100% of literacy is planned by the government. At the rural level , the primary factor for introducing any form of policy is the scope of education. A minimum standard of education should be available to everyone in the village group to provide environmental education and health knowledge for each village. This industry should, therefore, be strengthened in the district.

3.13 Health Services:

The distribution of health facilities differs in rural and urban areas. A similar condition occurs in the district of Chamarajanagara. There are a large number of private hospitals , nursing homes and polyclinics in the metropolitan region. One Community Health Centers (CHC's), 18 Primary Health Centers (PHC's) form the total health centres of the district, 15 operating 24X7, 81 Sub Centers.

3.14 Trade and Commerce:

The headquarters of the taluk were all and the centres of commerce and commerce are the municipal towns. In the taluk headquarters, all the towns have commercial and bank branches, agricultural produce markets and sub-markets to help farmers obtain better prices were set up. There were 33 commercial banks and 5 cooperative banks in 1991, with Chamarajanagara taluk

topping the list, followed by Kollegala, Gundlupete and Yelanduru with 12, 5 and 3. In addition to the taluk level, primary land development banks operate to provide farmers with medium and long-term loans to sink irrigation wells, energise the plumpest and reclamate cultivable lands. Given its success in the production and use of irrigation facilities, the exploitation of forest resources and the potential for sericulture, it can be concluded that one of the state's prosperous districts is the district of Chamarajanagara.

3.15 Transport and Communication:

Due to the recognition as an independent district on 15 August 1997, the district as Chamarajanagara is well served by a wide network of roads linking all villages and important trade centres outside the district. Both taluks are well served by transport communication; Chamarajanagara, Gundlupet and Kollegala taluks are the border area of the state of Karnataka and linked to the neighbouring states of Tamilnadu and Kerala. This district is crossed by national highways such as NH 181, NH 209 and NH 766. Village roads are more than half of the current roads. In fact, 36.73 percent of the total road length is made up of village roads. Whereas in the Chamarajanagara district, state highways and district roads account for 8.04 percent and 14.42 percent of the total road length, respectively.

The Tirupati Express (213) has been extended to Chamarajanagara Station since February 2010, and it is the only long-distance train from Chamarajanagara. In 2010, a survey for newlines between Chamarajanagara and Krishnagiri (Tamilnadu) was proposed by the railway budget. This line would directly connect Chennai and Mysore, which means that, instead of the busy Chennai-Bangalore-Mysore route, the new services will be via Chennai-Krishnagiri-Chamarajanagara-Mysore.

A survey for a new line between Tumkur and Chamarajanagara was proposed in the 2011 railway budget. Kunigal and Kollegala will go via this line. There is also a plan for a new railway line to be built between Kengeri and Chamarajanagara. The 2011-12 rail budget has been released with a new Mysore-Chamarajanagara passenger train. The total number of trains to and from this line will now be 6 plus 6.

In order to spread the socio-political activities of the planet, television and radio are the primary mass communication media. Mail and telegraph facilities are also within the reach of the masses of rural people. The sanitary facilities are not fine, although all villages have electricity and drinking water for drinking purposes. This could be one of the disadvantages for the rural masses in achieving quality healthcare benefits. In the following pages, the health facilities and programmes in the district will be addressed in depth on the basis of this Brief Geographic Information for the study area.

CHAPTER - IV

SPATIAL ANALYSIS OF PUBLIC HEALTH CENTERS

4.1: Introduction

Healthcare is characterized as a service program that makes all health facilities and allied resources available that are required to promote and sustain the health of the mind and body. Healthcare in India is impaired because it has to face serious crises in terms of cost, quality of care and equal delivery to the population as a whole of modes and standards of service (Mandal and Sinha, 1980). Practitioners such as doctors, nurses, health maintenance associations etc. provide healthcare tools. The regional technique for identifying inequalities in healthcare facilities is spatial analysis. The difference between the need for and demand for services is an essential question of fair service delivery (Meade and Earickson 2006). Access to healthcare requires a sufficient supply of health services for the community to be available. Healthcare resource availability is historically calculated using metrics such as the number of doctors or hospital beds per population unit.

Two components should be separated from access; initiation and continuation (Donabedian 1972). There is a significant difference between care access and care receipt (Le Grand 1982; Mooney 1983). Entry depends on opportunities, whereas the reception of care depends on both these possibilities and whether they have been used by individuals (Wagstaff and Doorslaer 2000). Entry to mean-receipt of care is usually described in the literature. Access is thus a dynamic term and it is generally accepted in the literature that access in the pursuit of health care is a result of more than just the cost of time and resources. Income (Olsen and Rogers 1991) includes the concept of facilities, efficiency, personality, annoyance, expense and data (Goddard and Smith 2001). To describe access as the right to use health care, Thiede et al.

(2007) takes a broader approach. With regard to three dimensions: availability, affordability and acceptability, these authors describe access. Availability applies to geographical availability and also to whether the resources provided to different population groups are equally accessible. Affordability applies, in the broadest sense (e.g., direct costs, indirect, household financial assets), to financial access. Acceptability refers to the view of patient health facilities, including the attitude of health staff towards patients, the culture of patients towards health services, the state of the facility, waiting times, length of appointments and the quality of public versus private care.

The location of health centers depends on the population, regional environment, system of transport and communication, health status and cleanliness of the health centers. Healthcare facilities are typically not delivered uniformly. Geographical and economic variables are the reasons for this. The use of healthcare facilities is distinct locally. The reason for this is the differences between rural and urban areas in the location of healthcare services. Because of their general interest in the spatial variance of phenomena on the earth's surface, the study of geographical differences in the delivery of social services (like healthcare) has caught the interest of geographers, planners and other scientists. Healthcare is a range of programs offered to patients, families, and communities. For fellow human beings, it is a worry.

4.2: Healthcare Resources in Chamarajanagara Taluk

The current chapter shows the availability of hobli-level health care services in Chamarajanagara Taluk. In addition, there is discussion of the availability of healthcare services, healthcare institutions, health workers and health infrastructures. Chamarajanagara Taluk has 5 Hoblis. Taluk have 18 Primary Healthcare Centers (PHC), 1 Community Health Center, 81 sub centers existed in the taluk.

i. District Hospital

District Hospital (DH), Community Health Centers (CHC), preceded by Primary Health Center (PHC) and Sub-Centers (SC), form the organizational structure of health services. The Chamarajanagara District Hospital is thus considered to be the Center for health services, consisting of a regional hospital with comparatively advanced treatment, diagnostics and intensive care facilities compared to other health centers. It serves almost 1,000 patients a day. It also offers healthcare facilities at higher levels, such as surgery, scanning, X-ray, laboratory services, etc. There are 10 specialist hospital departments, including surgery, orthopedics, general disease, pregnancy, child care, eyes, ear-nose-throat (ENT) and skin. In addition to these departments, an ambulance room also works on a 24-hour basis to meet people's emergency health care needs. It is the block level referral unit for complicated diseases for primary health centers and community health centers.

ii. Community Health Centers

As the first referral unit for the population of the medical block, the secondary level of healthcare includes Community Health Centers (CHC's). The CHC was designed to provide referral health care for cases directly entering the center from the Primary Health Centers and for cases in need of specialist care. Specialist services are offered by these CHC's and referred cases from nearby PHC's and SC's are received by them. They form a significant connection between one side of the SC, PHC and Health Units, and the other side of the district hospital.

Each CHC is entitled to serve 4 PHC's thus catering to serve approximately 80,000 populations One Community Health Center is located in the Hobli of Santemarahalli. There are 3 medical practitioners in this center, such as physicians and gynecologists. There are 8

paramedical workers and other support staff employed to provide the city with reliable health services. These CHC's are fitted with 10 hospital bed facilities and are fitted with X-ray space, labour room, operation theatre and laboratory facilities. It serves almost 100-200 outpatient patients a day.

iii. Primary Health Centers

Primary healthcare is a realistic approach that, with full participation, makes required healthcare widely accessible to individuals and families in the community in an appropriate and affordable manner (Ramachandran L, 1979). The Primary Health Center plays a vital role in emphasizing preventive rather than curative services in the health care system. It is the peripheral and most significant outpost around which health care facilities are given. It provides people living in rural areas with extensive healthcare services. PHC extends both outdoor and indoor therapy facilities as well as field services such as vaccination, family planning, management of blindness and leprosy, etc. School health services are also one of the primary health center's roles, it is well developed with sufficient staff to assess all school-going children, provide teachers with health education and training.

In the study, there are 18 PHC's, 15 of which operate 24x7 with operation theatre facilities, ambulance services for emergency referrals. The facilities of the operation theatre are mostly for family planning and minor emergency services. In order to decrease infant mortality rates at all levels, the vital service for newborn care is introduced in these units. Dais and Junior Health Assistants are also provided instruction in order to prevent hazardous deliveries in rural areas in their homes.

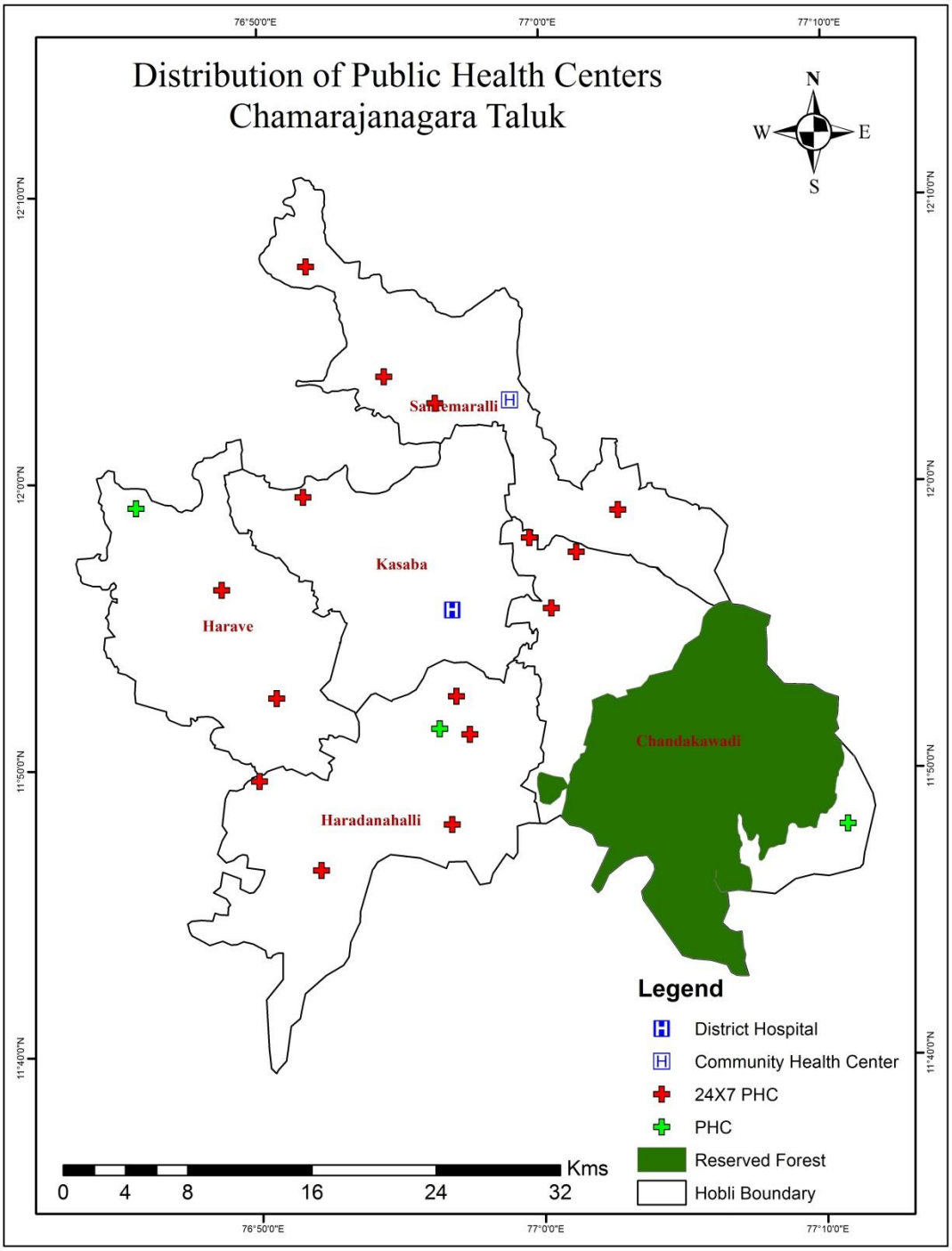
4.3: Spatial Analysis of Distribution of Health Centers

Geographical variations in population and population demand for health care provide the basis for the study and preparation of health services. People do not spread uniformly across the surface of the Planet, and communities vary across several dimensions, including age, gender, culture, and economic status, affecting their health care needs, their willingness to travel to access health care, and the kinds of services they are willing and able to use. GIS is increasingly used to map and examine regional differences in the demand for health services and to establish novel health care demand indicators (John Spencer and Gustavo Angeles, 2007). Health care services in every country can be categorized into two main categories known as primary health centers and hospitals. The former offers general health care services and the latter provides advanced health care services. Health authorities have always sought to provide health services to all people by means of a policy of equal access that is defined as delivering the right treatment at the right time in the right place (Divya.S et.al 2012). The details of Distribution of Health Care Centers and Information are given below.

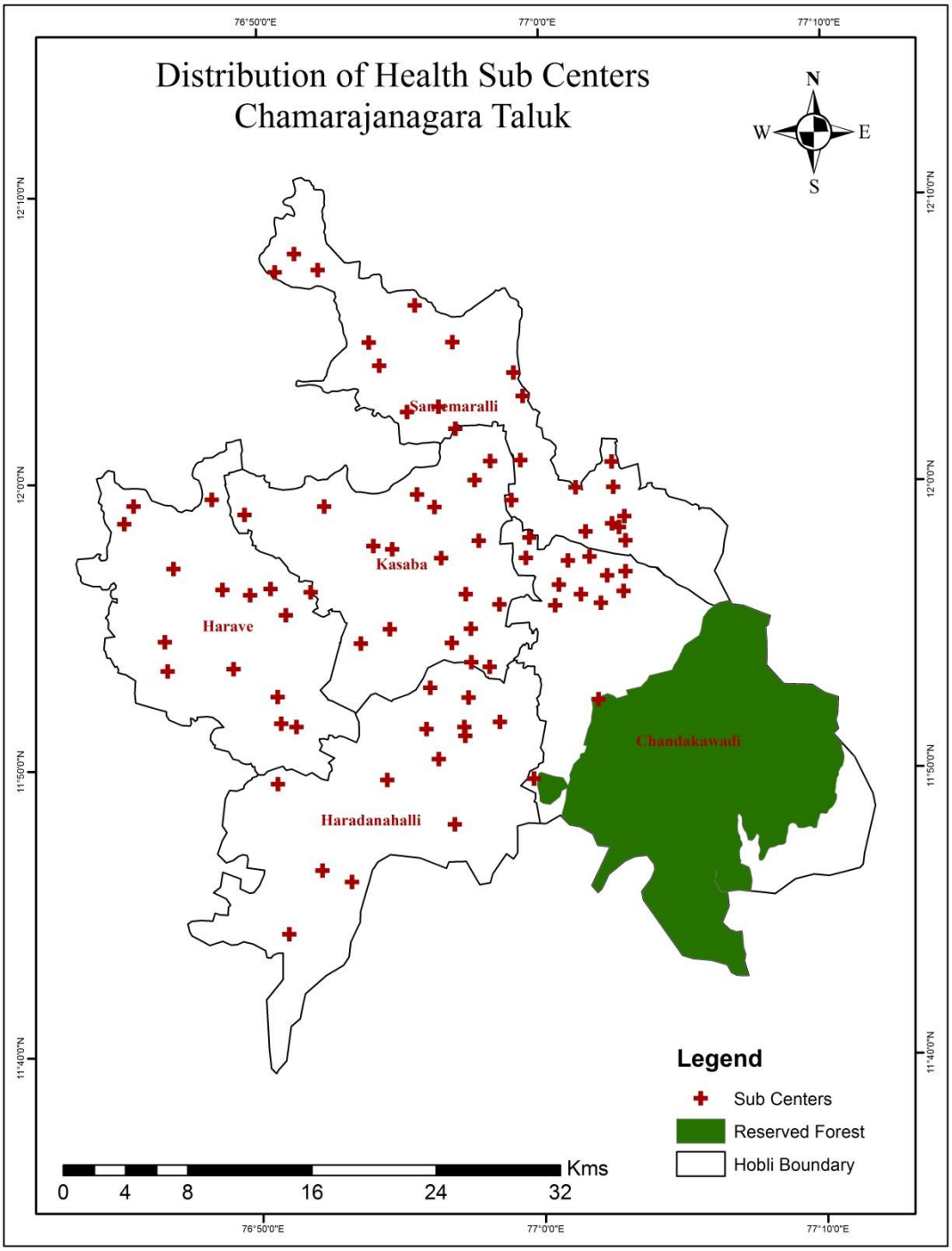
Table 4.1: Healthcare Institutions

Institutions	**Name of the Hobli**					Total
	Santemarahalli	Kasaba	Harave	Haradanahalli	Chandakawadi	
DH	-	1	-	-	-	**1**
CHC	1	-	-	-	-	**1**
PHC	4	1	3	6	4	**18**
SC	21	19	15	13	13	**81**

Source: District Health Office, Chamarajanagara 2019


Distribution of Public Health Centers
Chamarajanagara Taluk
N
W
E
S
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
Kasaba
Harave
Chandakawadi
Haradanahalli
Legend
District Hospital
Community Health Center
24X7 PHC
PHC
Reserved Forest
Hobli Boundary
0 4 8 16 24 32
Kms

Map 4.1


Distribution of Health Sub Centers
Chamarajanagara Taluk
N
W
E
S
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
Samemaralli
Kasaba
Harave
Chandakawadi
Haradanahalli
Legend
Sub Centers
Reserved Forest
Hobli Boundary
Kms
0
4
8
16
24
32

Map 4.2

Inequality in the provision of health care has become an issue in numerous countries (Mackenbach et al., 2008). In most health systems, fair provision of health care and fair accessibility to that care has become a major concept (Horev et al., 2004). Therefore, recognizing the regional distribution of health facilities, equitable accessibility and enhancement of these facilities will contribute to greater preparation in order to make health services available to everyone.

One of the most important goals to be accomplished by health systems in any country all over the world is the equal and fair distribution of resources in the health sector. It is generally regarded as one of the key problems and concerns of health sector decision makers and managers (Nishiura et al., 2004). Different methods have been analyzed determine the distribution of healthcare services such as Average Nearest Neighbor Analysis, Location Quotient, Lorenz curve methods and Gini coefficient. This will help to understand the essence of health service accessibility and help to minimize disparities in the distribution of healthcare services in Chamarajanagara Taluk.

i. Average Nearest Neighbor Analysis:

The average nearest neighbor is a measure of the distance between each spatial characteristic and its nearest neighbor points. All these distances are then summed and compared to a random distribution that is hypothetical. The spatial pattern of the characteristics being observed is considered to be clustered if the average distances of the observed distribution are less than the average of an expected distribution. In this instance, the value of the average nearest neighbor ratio is less than one. The spatial pattern, on the other hand, is called dispersed if the average distance is greater than the predicted distribution. In this case, the value of the

average nearest neighbor ratio is bigger than one (ESRI 2015). The average nearest neighbor ratio is determined on the basis that the distances observed are separated by the distances predicted for the same number of features covering the same region of the sample.

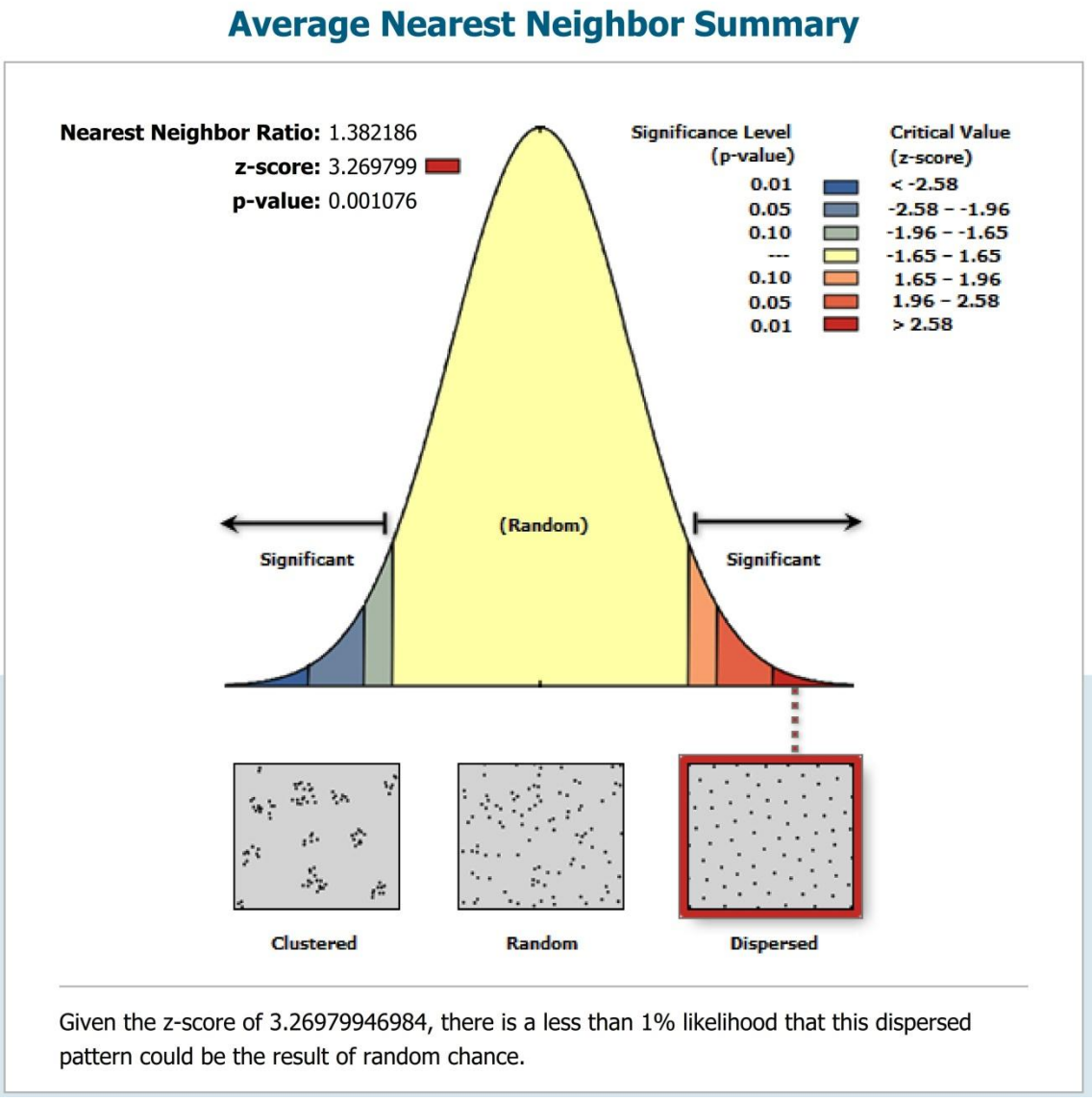


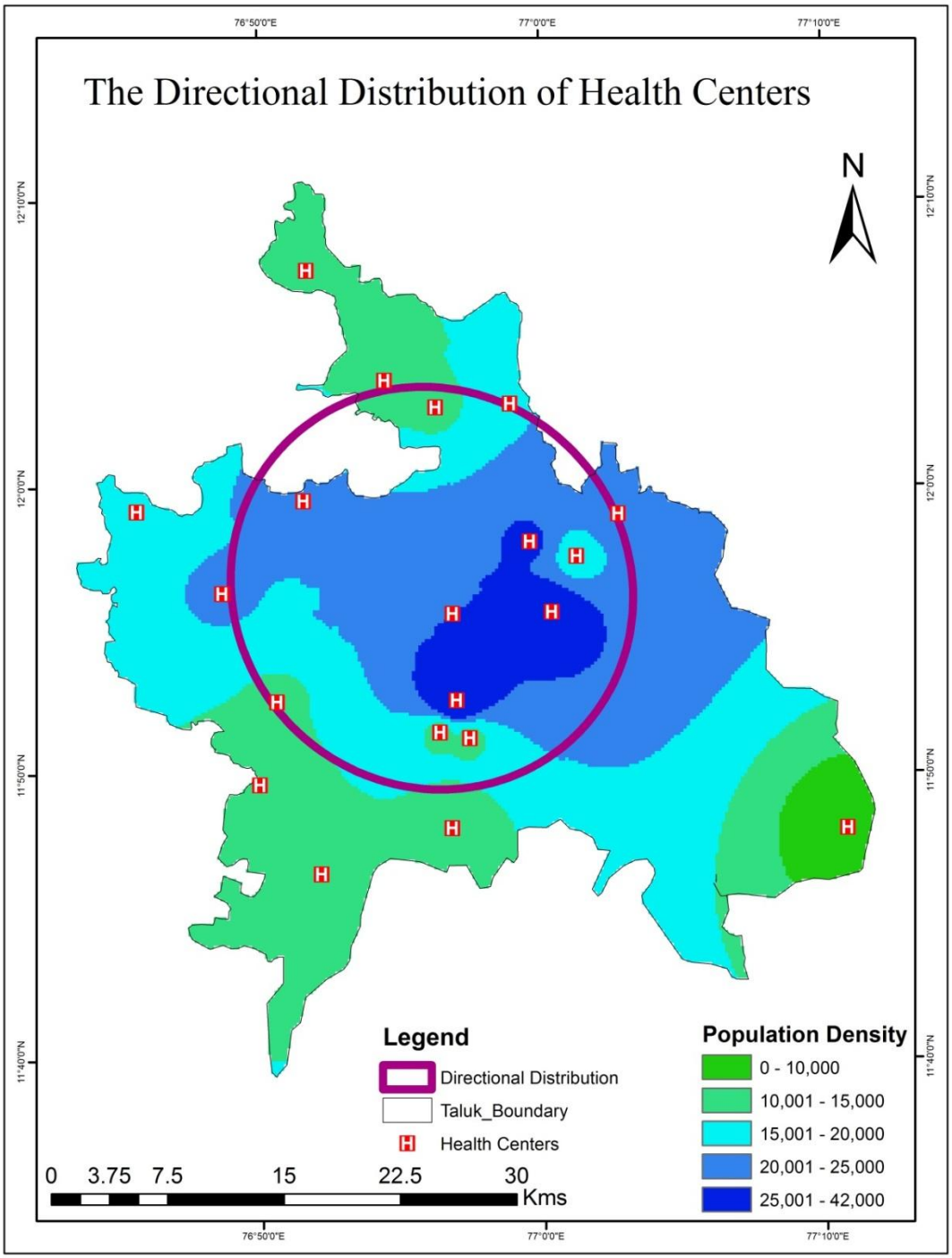
Fig 4.1

To assess the spatial pattern of distances among Public Health Centers, the average nearest neighbor tool within ArcGIS 10.3 was used and the finding revealed that Public Healthcare Centers across Chamarajanagara taluk were spatially dispersed (Fig 4.1). The

average nearest ratio was 1.382 ($p < 0.001$) and the Z-Score was 3.269 ($p < 0.001$). Therefore, the null hypothesis of no spatial pattern among public health centers in Chamarajanagara taluk was rejected. Due to the large Z-Score, there is less than 1% likelihood that this is dispersed pattern could be the result of random chance.

ii. Directional Distribution of Healthcare Facilities:

A common way of calculating the trend for a set of points or areas is to estimate the standard distance separately in the x- and y- directions. These two actions define the axes of an ellipse encompassing the distribution of features. The ellipse is referred to as the standard deviational ellipse; the ellipse allows you to see if the distribution of features is elongated and hence has a particular orientation.


The Directional Distribution of Health Centers
N
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
Legend
Directional Distribution
Taluk_Boundary
Health Centers
0 3.75 7.5 15 22.5 30
Kms
Population Density
0 - 10,000
10,001 - 15,000
15,001 - 20,000
20,001 - 25,000
25,001 - 42,000

Map 4.3

iii. Location quotient:

The spatial concentration pattern for facilities in a given area is established by the location quotient. The position quotient is a metric for comparing a specific facility's percentage share with its percentage share of the population. This approach is used to demonstrate the difference in the concentration of health centers among the district taluks. The following formula has been used to measure the position quotient (L.Q.) for health centers in a specific taluk.

$$LQ = \left(\frac{hh}{ph}\right) / \left(\frac{Ht}{Pt}\right)$$

Where:

LQ= Location Quotient

hh= Number of health centers in particular hobli

ph= Population of the concerned hobli

Ht= Number of health centers in the taluk

Pt= Population of the taluk

If the value of the quotient for a particular facility is equal to 1, it means that the facilities are fairly distributed. If the quotient value for a specific facility exceeds 1 that means that the concentration exceeds the average for the district. A value less than 1 indicates a service deficit, while a value equal to l or similar to l indicates autonomy (Isard et.al, 2017).

(a) Location Quotient of PHC

Table 4.2: Location Quotient of Primary Health Centers

Hoblis	Population	% of Pop	PHC	% of PHC	LQ
Chandakawadi	55593	15.54	4	22.22	1.43
Harave	48092	13.44	3	16.67	1.23
Haradanahalli	57696	16.13	6	33.33	2.06
Kasaba	125259	35.00	1	5.56	0.15
Santemarahalli	71159	19.89	4	22.22	1.11
Total	**357799**	**100**	**18**	100	

Source: District Health Office, Chamarajanagara

The table 4.2 shows that at hobli level, the primary health centers vary. In Haradanahalli Hobli (2.06), the degree of location quotient for PHCs is higher; it indicates that its population has more PHCs available. The Location quotient value is 1.43, 1.23 and 1.11 in Chandakawadi, Harave and Santemarahalli Hoblis, respectively, which means that the facilities are self-sufficient for the its population. While the value is less than 1 in Kasaba Hobli that is 0.15, which shows that the facilities are population deficient. But the reason for having less PHC is that in this hobli, there is District Hospital. The location quotient of the hoblis indicates that higher the value more facilities are available to the population and vice versa.

(b) Location quotient of Sub-Centers

Table 4.3: Location Quotient of Sub-Centers

Hoblis	Population	% of Pop	SC	% of SC	LQ
Chandakawadi	55593	15.54	13	16.05	1.03
Haradanahalli	57696	16.13	13	16.05	0.99
Harave	48092	13.44	15	18.52	1.37
Kasaba	125259	35.00	19	23.46	0.67
Santemarahalli	71159	19.89	21	25.93	1.30
Total	**357799**	**100**	**81**	**100**	

Source: District Health Office, Chamarajanagara

The table 4.3 depicts that the sub-centers are also not equally distributed at hobli level. The location quotient value of SC‘s is higher in Harave (1.37), Santemarahalli (1.30) and

Chandakawadi (1.03), which depicts more number of SC‘s available to its population, while in Haradanahalli and Kasaba Hobli the value is less than 1, that is 0.99 and 0.67 respectively, which reveals that the facilities are deficit to the population.

iv. Lorenz curve

The special form of graph (Lorenz Curve) is widely used to calculate disparities in order to get a better understanding of the spatial trend index with respect to Healthcare Centres. The Lorenz curve contrasts the distribution of a given variable with a uniform distribution representing equality. This constant distribution is shown by a diagonal line. The curved line travels away from this line of equality, and the disparity in the distribution of this phenomenon appears to increase, and vice versa. In this curve, the horizontal axis (P) represents the total percentage of the Health Centre’s wise population and the vertical axis (Q) indicates the percentage of those values kept by the corresponding cumulative proportion of the Health Centre. In our analysis, the P axis shows the cumulative percentage of the population of the Chamarajanagara District and the Q axis shows the cumulative percentage of health centres in the Chamarajanagara District. An Inequality Measure known as the Gini Coefficient for Health Centers has been measured using the Lorenz Curve. The Gini Coefficient is an aggregate measure of inequality and can differ from 0 (Perfect Equality) and 1 (Perfect Inequality) everywhere. The Gini‘s Coefficient is calculated from the following formula.

$$G = \frac{1}{1000}\left[\sum piqi + 1 - (\sum pi + 1qi)\right]$$

As per the norms of National Health Mission (NHM) the population norms for the provision of Sub- Centers, PHC’s and Community Health Centers are suggested 5000, 30,000, 1,20,000

people respectively in plain areas, whereas in the Hilly/Tribal regions it is 3,000, 20,000, 80,000 respectively.

Table 4.4: Population – PHC and SC Ratio (2011)

Hoblis	Population	No. of PHC	PHC Population Served	No. of SC	SC Population Served
Chandakawadi	55593	4	1:13898	13	1:4276
Haradanahalli	57696	6	1:9616	13	1:4438
Harave	48092	3	1:16031	15	1:3206
Kasaba	125259	1	1:125259	19	1:6593
Santemarahalli	71159	4	1:17790	21	1:3389
Total	**357799**	**18**	**1:19878**	**81**	**1:4417**

Source: Compiled by Author

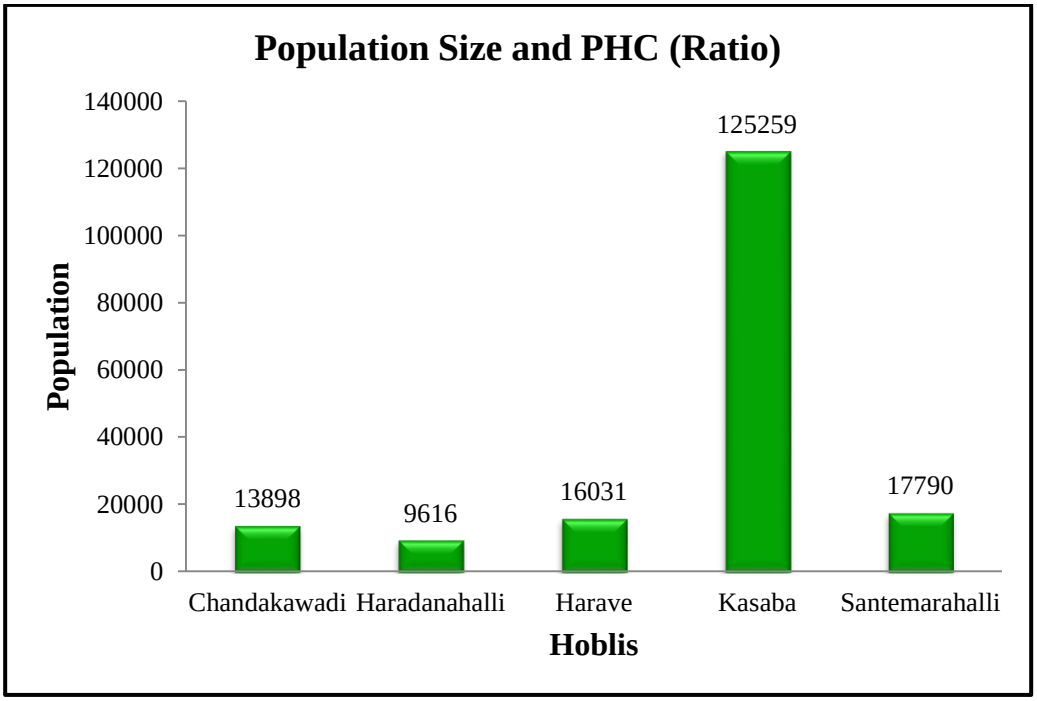


Fig 4.2

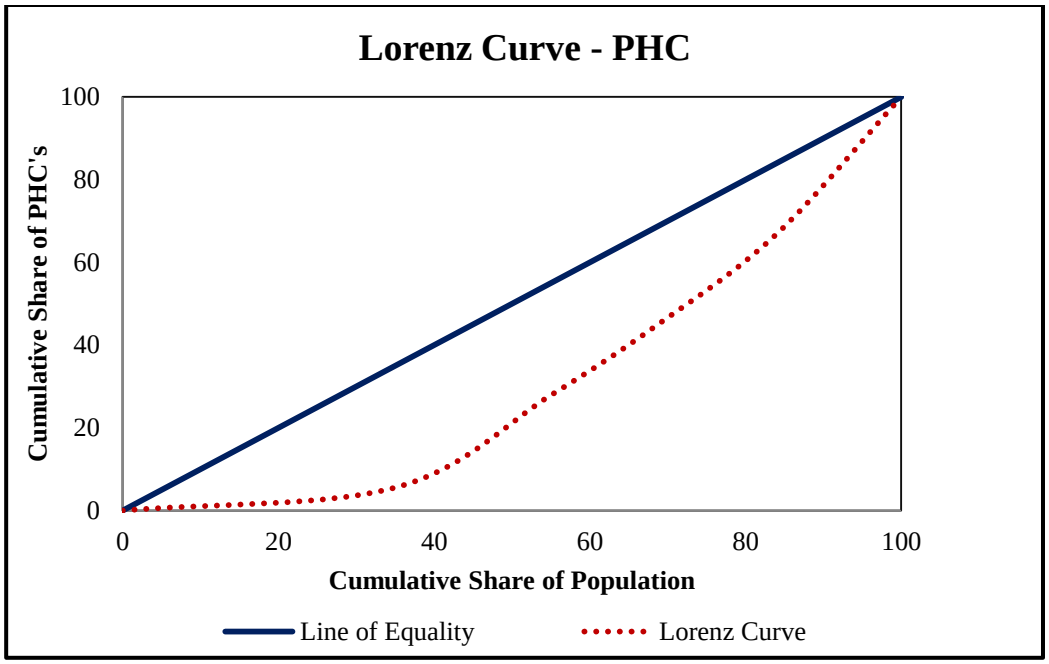


Fig 4.3

At the hobli level, the available PHC's are considered to assess the nature of availability and to study the level of availability with the guidelines in compliance with the Government of India's health policy requirements. On an average each PHC in the taluk is serving 19878 persons, which is less than the state average (1: 26463) indicates better status in term of number and population served by each PHC. The PHC's population ratio except in Kasaba hobli is less than the districts average (Table 4.4 and Fig. 4.2). High concentration of PHC's are found in Haradanahalli hobli (6), serving the population of 9616 and in Chandakawadi hobli each PHC is serving an average population of 13898, it indicates these taluks are better placed in respect of PHC's and their population providing services to the people. In Santemarahalli (4) and Harave (3) hoblis each PHC's are serving 1:17790 and 1:16031 respectively. In Kasaba hobli only one PHC is available; this reveals that the PHC's in this hobli is under more pressure than neighbouring hoblis by serving an excess population of 20000 persons by each PHC. But when we compare the PHC population ratio in hoblis with the NHM it is less than the prescribed norms. Hence the people in these hoblis are having good healthcare facilities. The Gini's

coefficient value of serving population of PHC‘s at taluk level is 1.72 which indicates that the healthcare centers are unequally distributed which is shown in the Lorenz Curve (Fig 4.3). The Distributional Direction Ellipse describes that population distribution is more central. 10 PHC's are located inside this ellipse, where each PHC serves 1: 23144 populations, while 10 PHC's are located with 1:12633 serving population outside the ellipse. This suggests that the PHC serves more communities within the ellipse than the recommended NHM requirements. Health centres in this region face acute pressure from the population. To reduce population burden and increase the productivity of health centres, new health centres need to be established.

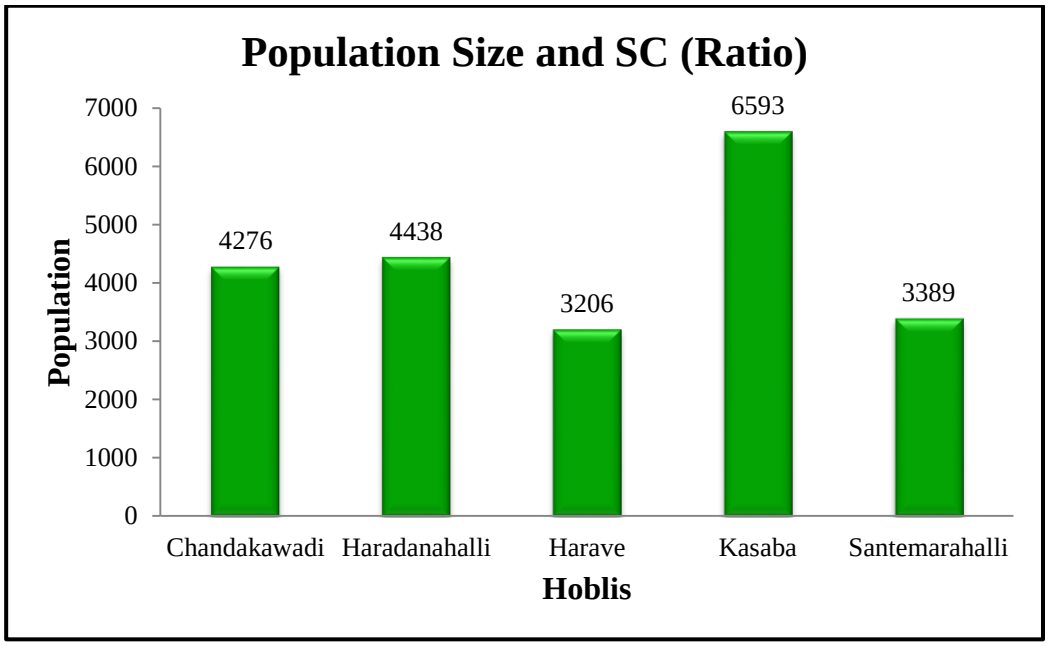


Fig 4.4

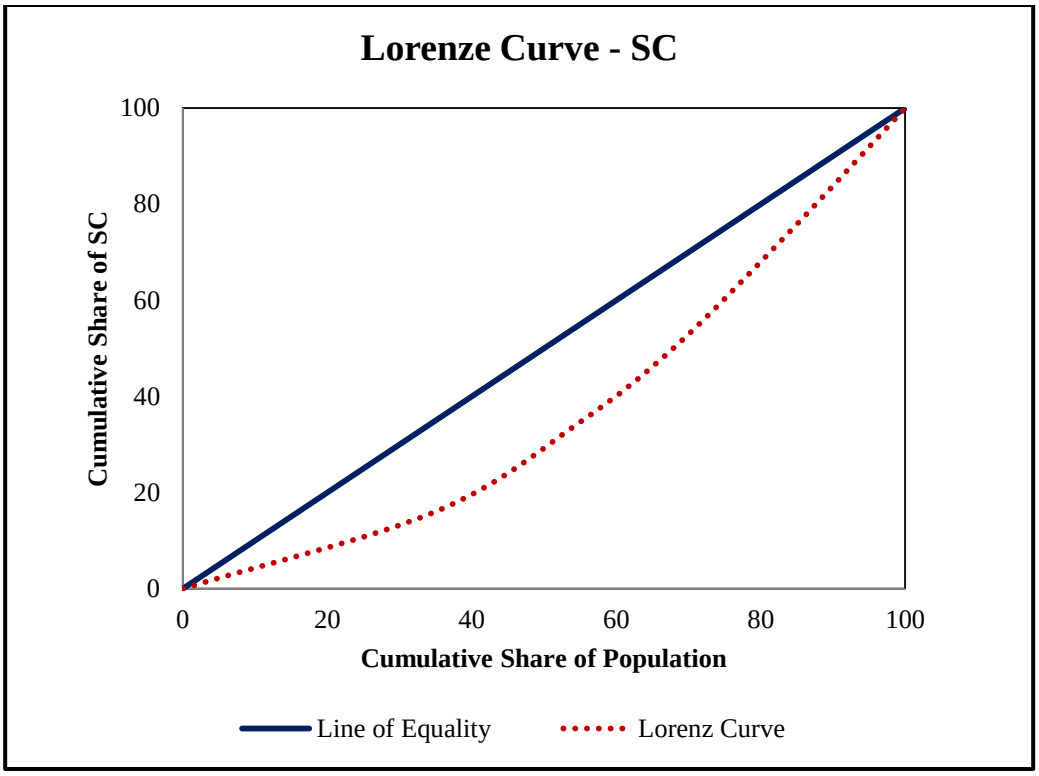


Fig 4.5

On an average each SC‘s in district is serving 4417 persons which indicate insufficient status of health facilities. However, the intra hobli inequality is also prevailing. The SC‘s of Harave (3206), Santemarahalli (3389),Chandakawadi (4276), and Haradanahalli Hobli (4438) are serving within the prescribed norms of NHM. In Kasaba hobli the SC‘s are serving an average population of 6593 persons more than the NHM norms. The above fact has revealed that the SC‘s of Kasaba Hobli is facing acute population pressure which is above the population norms prescribed by NHM. Similarly the Gini‘s coefficient value of SC‘s with the serving population at block level is also unequally distributed with the value 0.98.

4.4: Health Workforce

The word Health Workforce applies to doctors, nurses, dentists and pharmacists such as health practitioners (Matherlee 2003). It also extends to people interested in supporting, protecting or enhancing the population's health (Adams et al., 2003; Diallo et al., 2003).

The WHO described the word 'Health Workforce' in its World Health Report 2006 as all individuals engaging in activities that are specifically intended to improve health. The communities' healthcare obligations are focused on a number of health professionals who can be grouped as doctors, paramedical workers and other support staff.

i. Doctors

Doctors include doctors, surgeons and medical professionals from various fields of medicine. Physicians of Allopathy, Ayurveda and Unani medicine systems serve the field of study. Doctors from all public health agencies, such as District Hospitals, Block Hospitals, Community Health Centers and Primary Health Centers, are included in the number of doctors.

Table 4.5: Population – Doctors Ratio (2011)

Hoblis	Population	Doctors	Doctors Ratio
Chandakawadi	55593	3	1:18531
Haradanahalli	57696	3	1:19232
Harave	48092	6	1:8015
Kasaba	125259	4	1:31314
Santemarahalli	**71159**	**4**	**1:17790**
Total	**357799**	**20**	**1:17890**

Source: District Health Office, Chamarajanagara

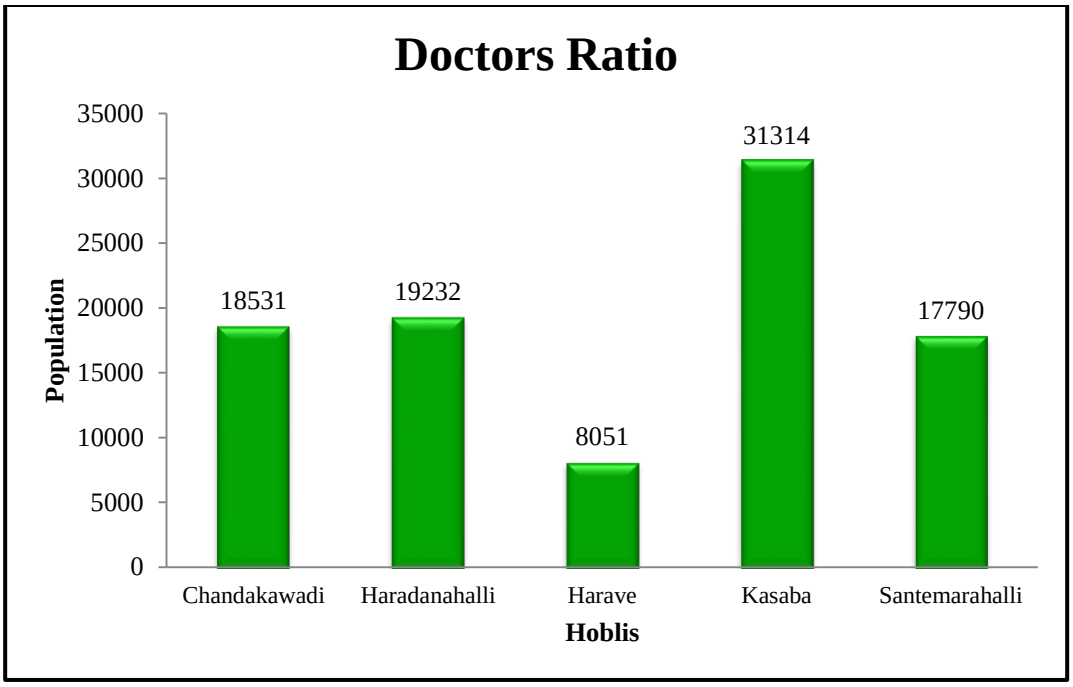


Fig 4.6

The taluk is served by 20 doctors in various public health institutions at an average doctor-population ratio of 1:17890, which is more than the state average (1:10260). This indicates the availability of doctors in the taluk is relatively very less than the state average. In Chamarajanagara taluk each doctor serves a population of 17890 persons which is greater than the state's figure. The doctor ratio in Harave hobli is 1:8015 better served by doctors when compared to other hoblis in the taluk.

ii. Health Workforce

Nurses, senior and junior health staff (male & female), lab technicians and pharmacists are paramedical staffs. Junior health workers are peripheral male and female workers who make home visits and provide preventive healthcare, maternal and child healthcare, immunization, communicable disease identification, health education for disease prevention to improve environmental healthcare, and inspiration for family planning. Accredited Social Health

Activists (ASHA) is proposed in the NRHM who will serve the population of 1000 in village. ASHA is the first port of call for any health related demands of deprived sections of the population, especially women, children, old aged, sick and disabled people. She is the link between the community and the health care provider. Accredited Social Health Activists (ASHA) is recommended in the NRHM to represent the village population of 1000. ASHA is the first port of call for any health-related requirements from vulnerable sectors of the population, especially women, children, the elderly, the sick and the disabled. She is the connection between the group and the provider of health care.

Healthcare centers have two responsibilities: (i) supplying trained medical personnel in hospitals and (ii) meeting the Millennium Development Goals of developing healthcare services to reduce various forms of diseases. The availability of a skilled workforce, in addition to cheaper technology, improved infrastructure, etc., will be one of the main factors in sustaining the expected growth of the healthcare industry in India. A global shortage of physicians, nurses and paramedical workers has led to an exodus of such manpower from India. A major challenge for our nation and the healthcare industry will be to sustain not only the health workforce, but also to create an atmosphere that would attract and return those abroad. The Available Health Workforce per 10000 people is shown in the following table.

Table 4.6: Available Health Workforce per 10000 people

Hoblis	Population	**Nurse**	**Jr.H.A**	**ASHA**	**OSS**
Chandakawadi	55593	1.61	5.03	5.75	1.97
Haradanahalli	57696	0.69	4.15	6.93	2.25
Harave	48092	1.24	4.36	7.27	2.70
Kasaba	125259	1.11	7.05	7.50	0.47
Santemarahalli	**71159**	1.68	3.09	4.21	1.54
Total	**357799**	**1.25**	**2.93**	**6.45**	**1.50**

Source: District Health Office, Chamarajanagara

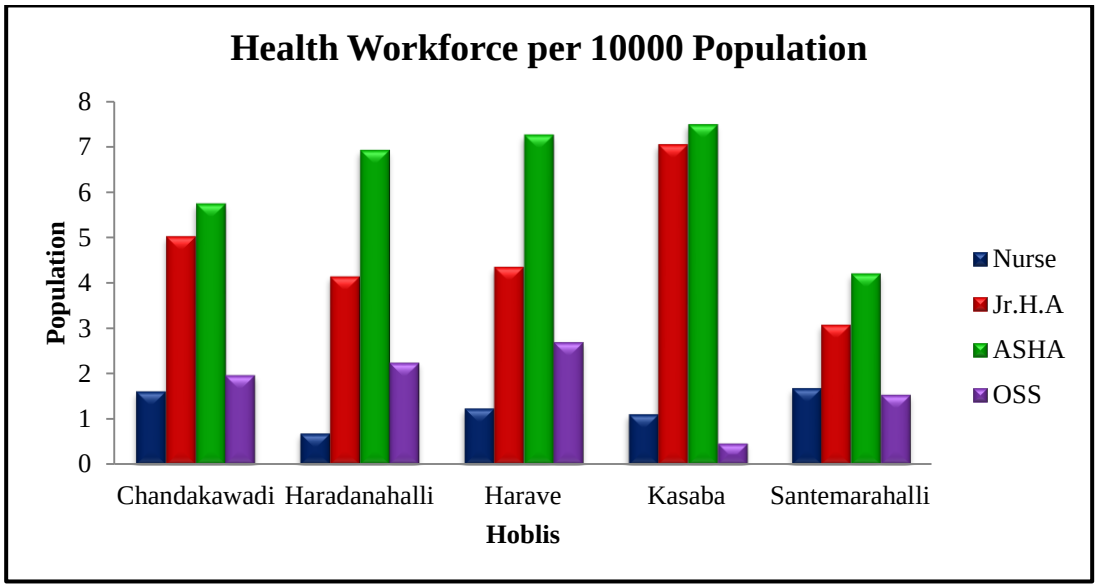


Fig 4.7

The above table presents the available health workforce per 10000 populations. The availability of Health Workforce per 10000 populations of hobli is very low as compare to WHO norms. As per the norms the availability of Nurse according to WHO norms is to be 0.99, except Haradanahalli hobli (0.69) all the hoblis have nurse ratio according to norms (Fig 4.7). The ratio of Jr.H.A per 10000 populations is only 2.93 at Chamarajanagara taluk. But according to WHO

norms it should be 7. In hoblis it varies from 3.09 in Santemarahalli to 7.05 in Kasaba hobli. Availability of ASHA is also very low as compared to standardized norms of WHO (10 per 10000 Populations).

iii. Health Infrastructure

Health infrastructure is an indicator to understand the healthcare delivery provision and mechanism in a country. Health infrastructure includes beds, blood storage unit, laboratory operation theatre, ambulance services etc. In the study area, there are 26 operation theatres, 20 laboratories (including laboratories in PHCs), 1 blood storage units, 16 emergency services and 2 X-ray units. The operation theatre facility is mostly for maternal treatment, family planning, not for surgery, and major emergency care facilities. Of 15 ambulances, 11 consisted of 108 providers. The laboratory is basic and has important laboratory equipment. For all public health centers, designated government buildings are available. The walls of the buildings are well plastered with plaster intact everywhere and the floor is in good condition. All health centers have compound walls all over. Potable water is associated with all health centers. The key sources of water are hand pumps and the overhead tanks linked with taps. The cleanliness of the OPD rooms, wards, toilets and premises in the health center is fine.

Table 4.7: Population – Beds Ratio (2011)

Hoblis	Population	Beds	Ratio
Chandakawadi	55593	40	1:1390
Haradanahalli	57696	45	1:1282
Harave	48092	56	1:589
Kasaba	125259	118	1:1061
Santemarahalli	71159	39	**1:1824**
Total	**357799**	**298**	**1:1200**

Source: District Health Office, Chamarajanagara

Availability of hospital beds are an important component of healthcare delivery system as they indicate the level of inpatient service available in any health establishment. Table 4.7 portrays the availability of hospital beds in the taluk. The average ratio of hospital beds to the population is 1: 1200 in the district. In Harave and Kasaba Hoblis each hospital bed is available for 589 and 1061 persons respectively, which is lower than the taluk average. Lower the bed-population ratio, higher the efficiency and effectiveness of healthcare. In Haradanahalli, Chandakawadi and Santemarahalli hoblis each hospital bed is available for 1282, 1390 and 1824 persons respectively, which is more than the taluk average.

However, as the serving population ratio of health centres is according to NHM guidelines, the residents of the taluk have good availability of health centres as a whole. Although the facilities are good enough to serve the taluk community, at the level of hobli, the spatial pattern of these facilities is unequal. Health services do not grow with the population, creating a disparity between the population ratio and the services of healthcare. Therefore, the number of healthcare centres and health workers in the study area needs to increase. Kasaba hobli health centres serve more people, while Haradanahalli hobli serves less people. Kasaba

Hobli serves more people in the health workforce, while Harave hobli serves less people. In such conditions, the number of healthcare centres and health workers in the study area needs to increase. The availability of healthcare services in Chandakawadi Hobli is insufficient and the accessibility of health centres is difficult due to the rough topography. New health centres need to be built, with a good number of staff needed. Since most of the study area is a hilly region, more mobile medical health units need to be developed to provide service to its people. The people who live in hilly region can easily access healthcare facilities in their doorstep. It should be noted that, for different reasons of physical distance, inaccessibility, lack of knowledge, cost and social distance, the health services available might be under-used.

In addition to the hospitals, health professionals (doctors, paramedical personnel and other support staff) and health resources (beds) are not adequately open to the community in compliance with the guidelines. Therefore, since this is the only solution to ensuring equality and social justice in the provision of health care and other essential facilities, the government should follow the population threshold as a measure for the distribution of health care facilities.

CHAPTER – V

ACCESSIBILITY TO PUBLIC HEALTH CENTERS

5.1: Introduction

Human health forms the basis of sustainable development of a community and demands an adequate and proper distribution of health facilities in a given region. Accessibility to health care is not only an essential consideration for a well-functioning society but is also a fundamental human right (Eklund and Martensson 2012). The term physical accessibility is the measurement of opportunities that people in an area have access to. Accessibility is based on a number of factors, such as service availability, user characteristics and outcomes (such as health status changes or the adoption of known efficacy interventions), while taking into account the complex and non-linear relationships between these elements (Pawson and Tilley 1997).

To evaluate the current and future optimal service location, access to health care can be measured using a straight line or road distance. In addition, health care accessibility studies focus on the identification of health catchments and the examination of health accessibility by social groups (Comber et. al., 2008). Nichols et al., 2014, presented another recent GIS application for mammography resource accessibility assessment in Mississippi, USA, showing the location of geocoded facilities together with the counties and major transportation networks in Mississippi, and defining areas within and outside the drive-time distance with respect to all mammography facilities based on an optimal drive-in drive. Bagheri et al., 2005, discussed a GIS application to measure spatial accessibility in New Zealand for primary health services and applied drive-time analysis to estimate the shortest time between any pair of population and health center locations through road networks.

Service areas built for accessibility evaluation are used to evaluate accessibility with different impedance cutoffs. The service area is generally used on the basis of time and distance to estimate travel time and distance from demand points to service centers, such as health centers, schools, fire stations, etc.

5.2: Methodology

This chapter examines the physical accessibility of the population to health centers in terms of distance and time using service catchment areas and the nearest facility. In the facilities they offer, health centers are not homogeneous and the analysis separately analyses accessibility to various types of hospitals. District Hospital (DH) and Community Health Centers (CHCs) was taken into consideration for assessing the accessibility to Primary Health Centers (PHCs) and for measuring the accessibility to CHCs, DH was taken into consideration because higher-order health centers provide all health facilities which are available in lower-order health centers. For time and distance accessibility for each health center, raster overlay tests were applied to assess overall accessibility to the district's health centers. Overlay analysis is a GIS operation that involves superimposing multiple layers of datasets representing various themes to analyze or classify the relationships between them. By combining data from two or more input data layers, new spatial data sets are generated in the overlay analysis. The raster overlay was used to demarcate the overall usable region of the research area in this study. In which vector data has been rasterized after measuring the accessibility of health centers at different distance and time intervals, these distance and time intervals have been given different weightage as per their accessible zones. Raster datasets combine Pixel-based calculations or Map Algebra; it is also known as cell by cell combination or operation. It is computationally less demanding. A numerical weighting factor has been assigned to each thematic layer according to its relative

importance compared to all other layers. After that, the weighted layers are overlaid as before mentioned in table 5.14 the raster overlay analyses were applied for time and distance accessibility for each health center separately and finally all together.

Table 5.1: Travel Distance and Travel Time to Nearest Health Center

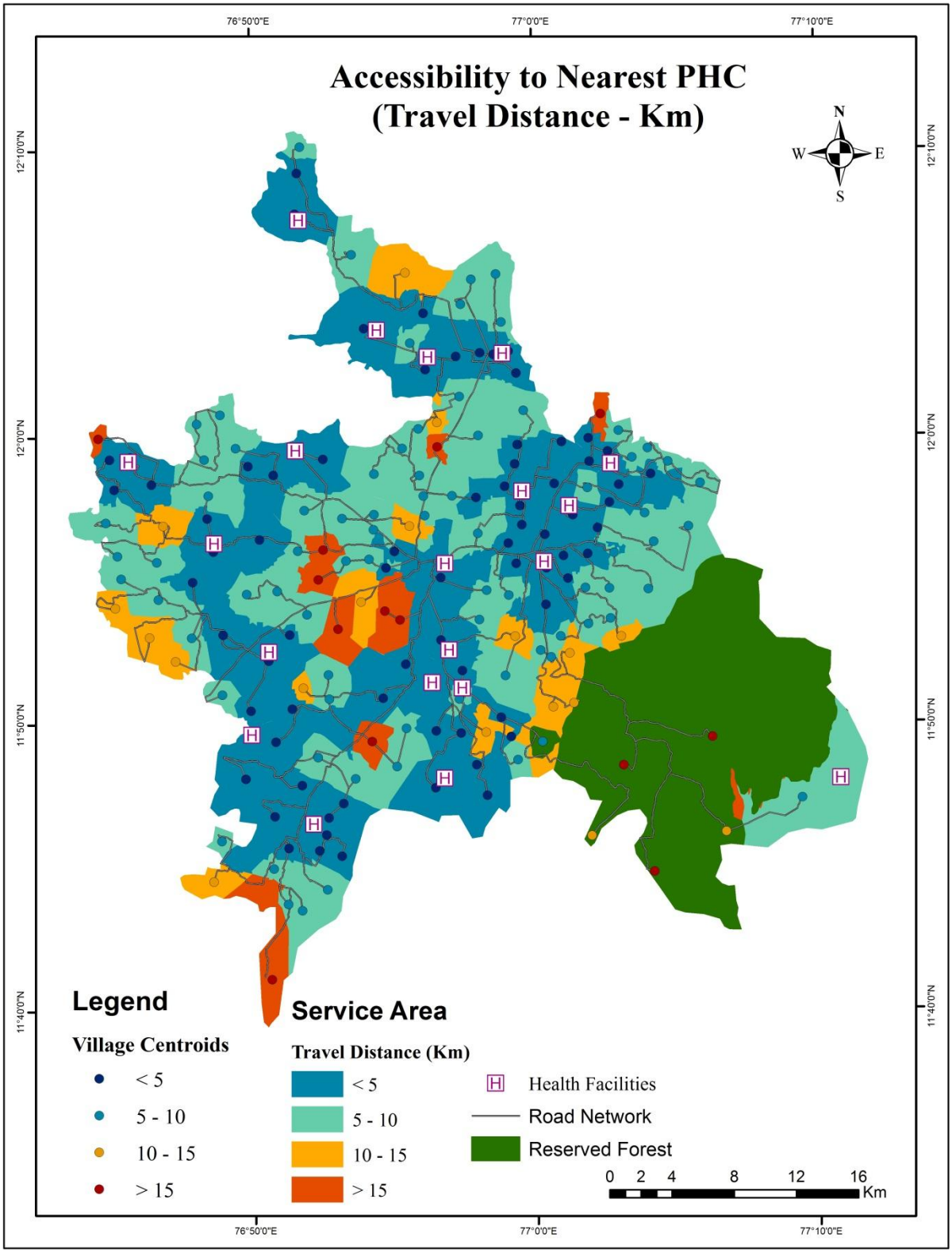
Scenario	Health Centers	Minimum	Maximum	Average	Standard Deviation
Distance	PHC	0.24	23.75	6.83	4.10
	CHC	0.66	50.58	25.41	11.31
	DH	3.27	41.10	18.59	8.37
Time	PHC	0.48	52.39	13.63	8.79
	CHC	1.33	111.39	43.34	21.23
	DH	4.74	85.40	32.78	19.06

Source: Compiled by Author

Table 5.1 displays that the average travelling distance to PHC is 6.83 km. The travel distance to the closest PHC ranges between (0.24) km to (23.75) km. whereas the average travelling distance to CHC and DH is 25.41 and 18.59 km respectively. The minimum travel distance to CHC and DH are 0.66 and 3.27 km respectively, whereas the maximum travel distance equals 50.58 km to CHC and 41.10 km to DH. Similarly the average travelling time to PHC is 13.63 minutes. The travel time to the closest PHC ranges between 0.48 minutes and 52.39 minutes, while as in case of CHC and DH the average travel time to near facility is 43.34 and 32.78 minute respectively. The minimum travel time to CHCs and DH is 1.33 and 4.74 minutes respectively, whereas the maximum travel time to CHC and DH are 111.39 and 85.40 minutes respectively.

5.3: Accessibility to Primary Health Centers

The service area of PHC‘s and the closest facility of centroids has been generated based on travel distance (km) within the impedance cutoff of 5, 10, 15 and 20 and for travel time within the impedance cutoff of 5, 15, 25 and 35 min.


Accessibility to Nearest PHC
(Travel Distance - Km)
N
W
E
S
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
Legend
Village Centroids
< 5
5 - 10
10 - 15
> 15
Service Area
Travel Distance (Km)
< 5
5 - 10
10 - 15
> 15
Health Facilities
Road Network
Reserved Forest
0 2 4 8 12 16
Km

Map 5.1

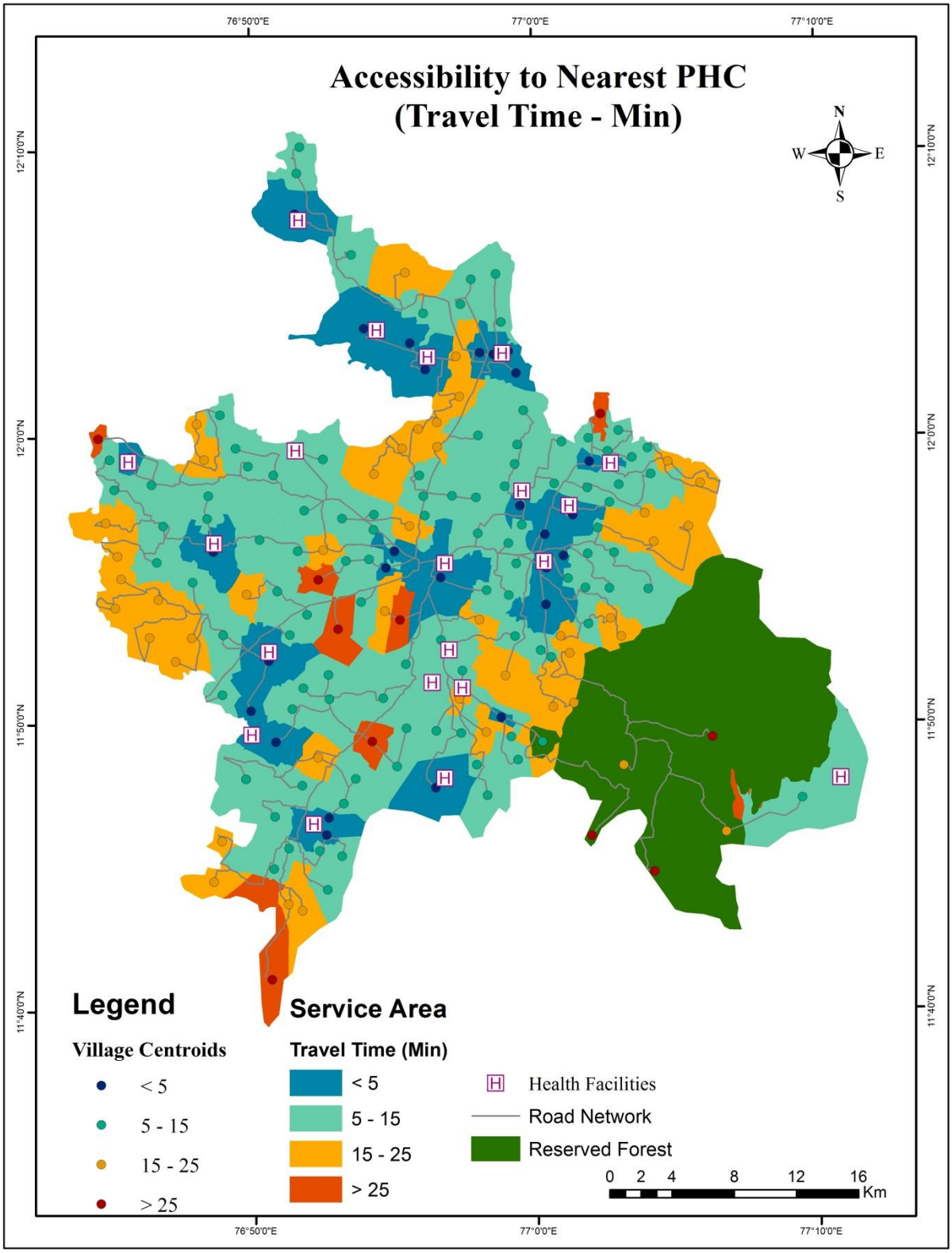
Table 5.2: Accessibility to PHC within specified Travel Distance (Km)

Villages and their population within specified travel distance (km)						
Hoblis		< 5	5 to 15	15 - 25	> 25	Total
Chandakawadi	Villages	12	12	6	3	33
	Percentage	36.36	36.36	18.18	9.09	100.00
	Population	32073	13227	4458	5835	55593
	Percentage	57.69	23.79	8.02	10.50	100.00
Haradanahalli	Villages	22	13	3	2	40
	Percentage	55.00	32.50	7.50	5.00	100.00
	Population	36876	13529	4450	2841	57696
	Percentage	63.91	23.45	7.71	4.92	100.00
Harave	Villages	13	16	5	2	36
	Percentage	36.11	44.44	13.89	5.56	100.00
	Population	21609	18835	6790	858	48092
	Percentage	44.93	39.16	14.12	1.78	100.00
Kasaba	Villages	8	20	3	5	36
	Percentage	22.22	55.56	8.33	13.89	100.00
	Population	78948	37035	1839	7437	125259
	Percentage	63.03	29.57	1.47	5.94	100.00
Santemarahalli	Villages	22	16	1	1	40
	Percentage	55.00	40.00	2.50	2.50	100.00
	Population	43748	21982	2642	2787	71159
	Percentage	61.48	30.89	3.71	3.92	100.00
Taluk	Villages	77	77	18	13	185
	Percentage	41.62	41.62	9.73	7.03	100.00
	Population	213254	104608	20179	19758	357799
	Percentage	59.60	29.24	5.64	5.52	100.00

Source: Compiled by Author

Map 5.1 and Table 5.2 show the number of villages and their population located within zones of specified distances from PHCs for all the hoblis of the district. The table reveals that majority of population (59.60 percent) of 77 villages have access with the travel distance of less than 5 km either by transport or even by walk. More than 60 percent of population of Haradanahalli, Kasaba and Santemarahalli hoblis has access to health centers within the distance of 5 km. The second zone of accessibility accounts 77 villages with 29.24 percent of population. A large proportion of population falling in this zone of accessibility is from the Harave hobli

39.16 percent. Within the travel distance of 15 to 25 km 5.64 percent of population have access to these facilities out of that 14.12 percent are from Harave followed by Chandakawadi and Haradanahalli hoblis with 8.02 and 7.71 percent of population respectively. 5.52 percent population has to travel more than 15 km to access the health centers, in which 10.50 percent are from Chandakawadi hobli.


Accessibility to Nearest PHC
(Travel Time - Min)
N
W
E
S
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
Legend
Village Centroids
< 5
5 - 15
15 - 25
> 25
Service Area
Travel Time (Min)
< 5
5 - 15
15 - 25
> 25
Health Facilities
Road Network
Reserved Forest
0 2 4 8 12 16
Km

Map 5.2

Table 5.3: Accessibility to PHC within specified Travel time (Min)

Villages and their population within specified travel time (min)						
Hoblis		< 5	5 to 15	15 to 25	> 25	Total
Chandakawadi	Villages	6	15	9	3	33
	Percentage	18.18	45.45	27.27	9.09	100
	Population	21304	19580	9278	5431	55593
	Percentage	38.32	35.22	16.69	9.77	100
Haradanahalli	Villages	5	25	8	2	40
	Percentage	12.50	62.50	20.00	5.00	100
	Population	8044	34686	12125	2841	57696
	Percentage	13.94	60.12	21.02	4.92	100
Harave	Villages	4	19	11	2	36
	Percentage	11.11	52.78	30.56	5.56	100
	Population	10573	25207	11454	858	48092
	Percentage	21.98	52.41	23.82	1.78	100
Kasaba	Villages	3	21	10	2	36
	Percentage	8.33	58.33	27.78	5.56	100
	Population	70505	37711	12632	4411	125259
	Percentage	56.29	30.11	10.08	3.52	100
Santemarahalli	Villages	10	23	6	1	40
	Percentage	25.00	57.50	15.00	2.50	100
	Population	23893	39972	4507	2787	71159
	Percentage	33.58	56.17	6.33	3.92	100
Total	Villages	28	103	44	10	185
	Percentage	15.14	55.68	23.78	5.41	100
	Population	134319	157156	49996	16328	357799
	Percentage	37.54	43.92	13.97	4.56	100

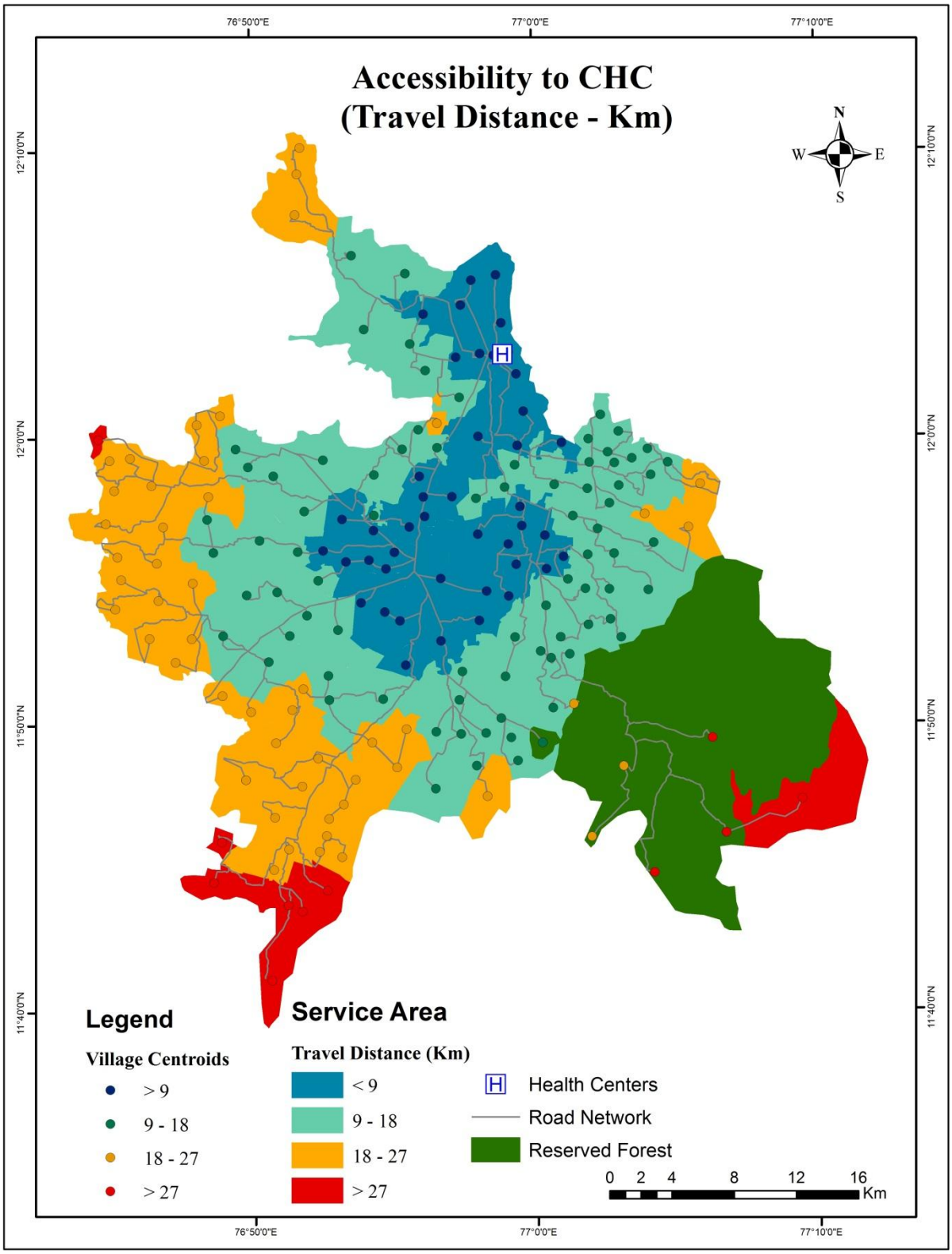
Source: Compiled by Author

The accessibility to PHCs from centroids based on travel driving time in minutes for PHCs facilities is depicted in Map 5.2 The number of villages, population and their percentage located within zones of specified time is shown in table 5.3 which reveals that majority of population (43.92 percent) of 103 villages have access with the travel time of 5 to 15 minutes; whereas 95.43 percent even have access by walk within the travel time of less than 25 minutes. There are 45.41percent (n=10) of villages which accounts the population of 4.56 percent which

have access within the travel time of 25.35 minutes.

5.4: Accessibility to Community Health Centers

The service area of community health centers and the closest facility to centroids has been generated based on travel distance (km) within the impedance cutoff of 9, 18, 27, and 36 km and for travel time within the impedance cutoff of 15, 30, 45 and 60 min.


Accessibility to CHC
(Travel Distance - Km)
N
W
E
S
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
Legend
Village Centroids
> 9
9 - 18
18 - 27
> 27
Service Area
Travel Distance (Km)
< 9
9 - 18
18 - 27
> 27
Health Centers
Road Network
Reserved Forest
0 2 4 8 12 16
Km

Map 5.3

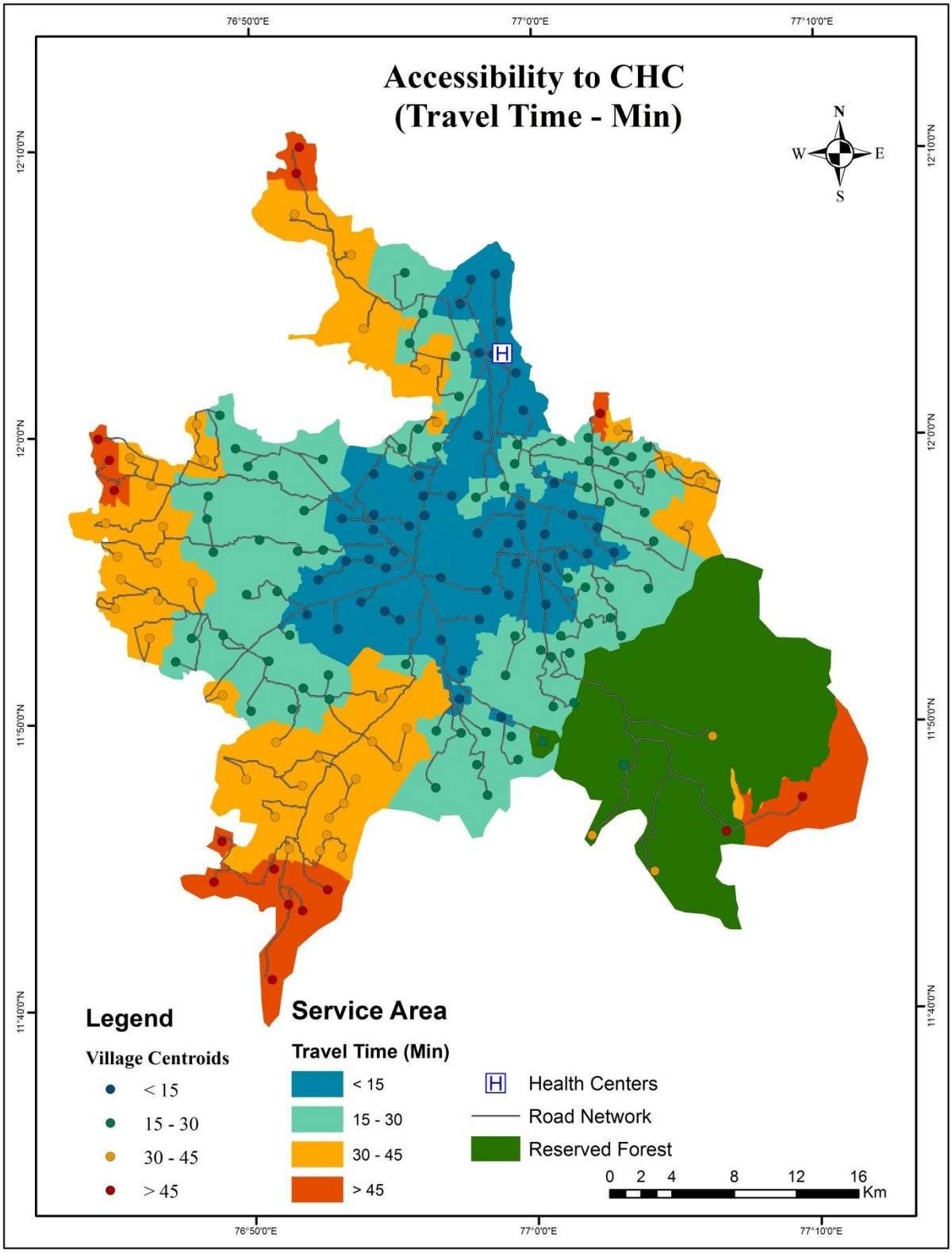
Table 5.4: Accessibility to CHC within specified Travel Distance (Km)

Villages and their population within specified travel distance (km)						
Hoblis		< 9	9 to 18	18-27	> 27	Total
Chandakawadi	Villages	6	20	3	4	33
	Percentage	18.18	60.61	9.09	12.12	100
	Population	14370	32892	832	7499	55593
	Percentage	25.85	59.17	1.50	13.49	100
Haradanahalli	Villages	2	14	18	6	40
	Percentage	5.00	35.00	45.00	15.00	100
	Population	5531	27132	18660	6373	57696
	Percentage	9.59	47.03	32.34	11.05	100
Harave	Villages	0	12	23	1	36
	Percentage	0.00	33.33	63.89	2.78	100
	Population	0	20939	26331	822	48092
	Percentage	0.00	43.54	54.75	1.71	100
Kasaba	Villages	22	13	1	0	36
	Percentage	61.11	36.11	2.78	0.00	100
	Population	102812	22339	108	0	125259
	Percentage	82.08	17.83	0.09	0.00	100
Santemarahalli	Villages	14	20	6	0	40
	Percentage	35.00	50.00	15.00	0.00	100
	Population	22533	41375	7251	0	71159
	Percentage	31.67	58.14	10.19	0.00	100
Total	Villages	44	79	51	11	185
	Percentage	23.78	42.70	27.57	5.95	100
	Population	145246	144677	53182	14694	357799
	Percentage	40.59	40.44	14.86	4.11	100

Source: Compiled by Author

The Map 5.3 and table 5.4 shows the number of villages and population and their percentage located within the accessible zones based on travel distance from the village centroids to health center. The table reveals that 40.59 percent of the population of 44 villages has access within the travel distance of less than 9 km. At the hobli level the highest percentage of population is in this zone of accessibility is from Kasaba with 82.08 percent followed by Santemarahalli and Chandakawadi with 31.67 and 25.85 percent respectively. People of Harave hobli do not have access to such facility within the distance of 9 km. The second zone of access

is 9 to 18 km within 40.44 percent of population; more than 55 percent of population from Chandakawadi (59.17) and Santemarahalli (58.14) has to access within this zone. There are 27.57 (51) of villages with 14.86 percent of the population have access within the travel distance of 18 to 27 km. Highest population in this zone of accessibility is from Harave hobli which accounts the population of 54.75 percent followed by Haradanahalli with 32.34 percent. A very less count of villages 5.95 percent which accounts for 4.11 percent of total population of the study area and have access to the nearest CHC within the travel distance of more than 27 km. In this zone of accessibility the highest population of 13.49 percent is from Chandakawadi, Harave share 11.05 percent of population. Hence, there is need of additional health center to reduce the distance of accessibility to health centers to improve the access.


Accessibility to CHC
(Travel Time - Min)
N
W
E
S
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
Legend
Village Centroids
< 15
15 - 30
30 - 45
> 45
Service Area
Travel Time (Min)
< 15
15 - 30
30 - 45
> 45
Health Centers
Road Network
Reserved Forest
0 2 4 8 12 16
Km

Map 5.4

Table 5.5: Accessibility to CHC within specified Travel Time (Min)

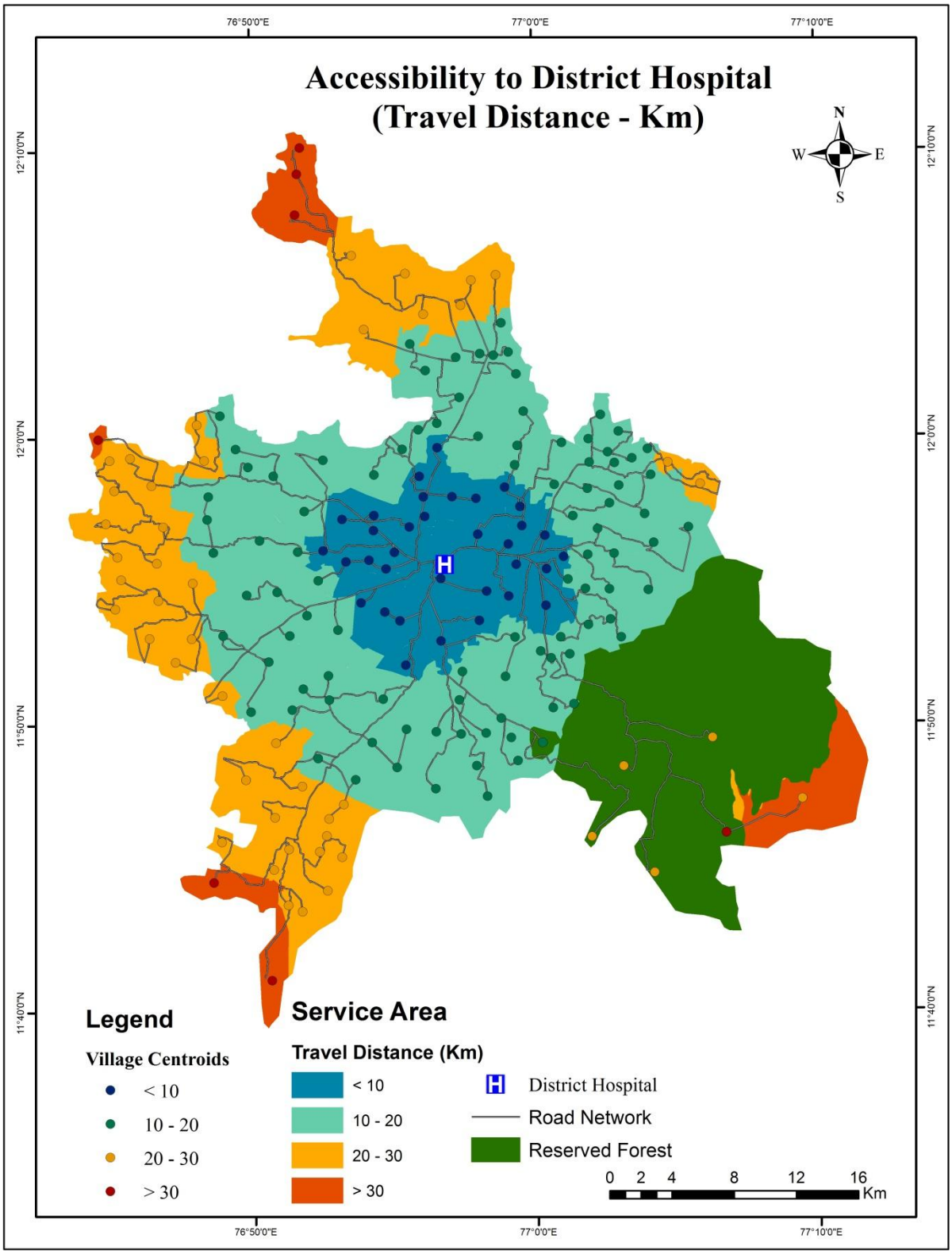
CHC Villages and their population within specified travel time (min)						
Hoblis		< 15	15-30	35-45	>45	Total
Chandakawadi	Villages	11	17	3	2	33
	Percentage	33.33	51.52	9.09	6.06	100
	Population	35112	12967	5431	2083	55593
	Percentage	63.16	23.32	9.77	3.75	100
Haradanahalli	Villages	4	12	17	7	40
	Percentage	10.00	30.00	42.50	17.50	100
	Population	11578	15064	24320	6734	57696
	Percentage	20.07	26.11	42.15	11.67	100
Harave	Villages	2	17	14	3	36
	Percentage	5.56	47.22	38.89	8.33	100
	Population	791	24784	19735	2782	48092
	Percentage	1.64	51.53	41.04	5.78	100
Kasaba	Villages	24	11	1	0	36
	Percentage	66.67	30.56	2.78	0.00	100
	Population	108060	17091	108	0	125259
	Percentage	86.27	13.64	0.09	0.00	100
Santemarahalli	Villages	10	19	8	3	40
	Percentage	25.00	47.50	20.00	7.50	100
	Population	16429	29542	19055	6133	71159
	Percentage	23.09	41.52	26.78	8.62	100
Total	Villages	51	76	43	15	185
	Percentage	27.57	41.08	23.24	8.11	100
	Population	171970	99448	68649	17732	357799
	Percentage	48.06	27.79	19.19	4.96	100

The accessibility to CHC's based on time is summarized in table and map. Majority of the population of the hobli 48.06 percent have access within the driving time of 15 minutes. Among hoblis the highest percentage of population in this zone of accessibility is from Kasaba hobli with 86.27 percent followed by Chandakawadi 63.16 percent. 27.79 percent of population has access within the travel driving time of 15 to30 minutes; out of that 51.53 percent of population from Harave and 41.52 from Santemarahalli in this zone. There are 23.24 percent of villages which account for 19.19 percent of population of the district having access within

driving travel time of 35 to 45 minutes. Highest population in this zone of accessibility is from Haradanahalli with 42.15 followed by Harave with the population of 41.04 percent. 8.11 percent of villages with 4.96 percent of the total population of the study area have access to the nearest CHC within the travel time of more than 45 minutes. In this zone of accessibility the highest population of 11.67 percent is from Haradanahalli, Santemarahalli constitutes 8.62 percent and the 5.78 percent of population is from Harave.

5.5: Accessibility to District Hospital

The service area and closest facility has been generated based on Travel distance of 10, 20, 30 and 40 km and travel time (min) within the impedance cutoff of 17, 34, 51 and 68 min.


Accessibility to District Hospital
(Travel Distance - Km)
N
W
E
S
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
H
Legend
Village Centroids
< 10
10 - 20
20 - 30
> 30
Service Area
Travel Distance (Km)
< 10
10 - 20
20 - 30
> 30
District Hospital
Road Network
Reserved Forest
0 2 4 8 12 16
Km

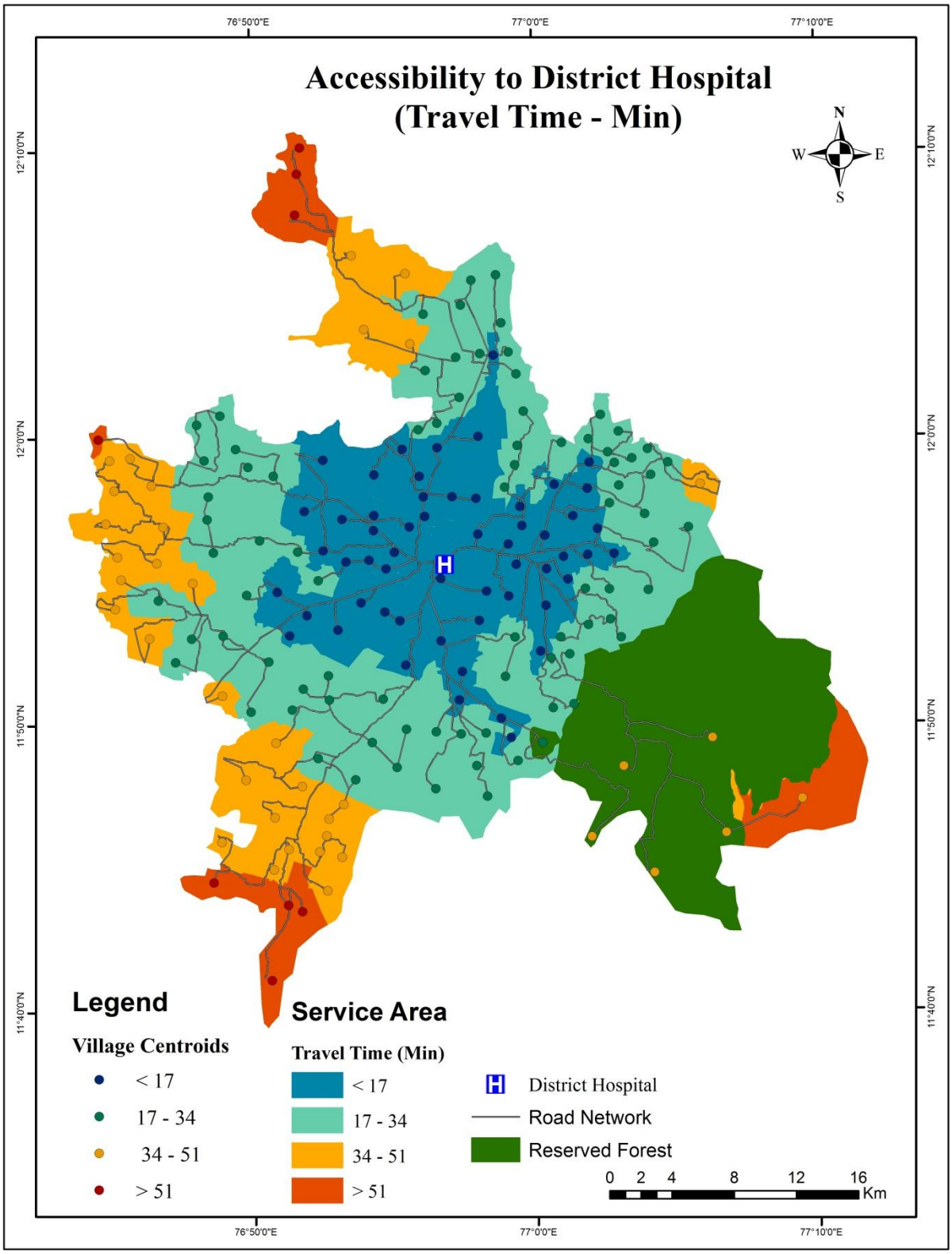
Map 5.5

Table 5.6: Accessibility to DH within specified Travel Distance (Km)

Villages and their population within specified travel distance (km)						
Hoblis		< 10	10 - 20	20 - 30	> 30	Total
Chandakawadi	Villages	8	19	2	4	33
	Percentage	24.24	57.58	6.06	12.12	100
	Population	19733	27927	434	7499	55593
	Percentage	35.50	50.23	0.78	13.49	100
Haradanahalli	Villages	2	17	19	2	40
	Percentage	5.00	42.50	47.50	5.00	100
	Population	5531	30676	18670	2819	57696
	Percentage	9.59	53.17	32.36	4.89	100
Harave	Villages	0	17	18	1	36
	Percentage	0.00	47.22	50.00	2.78	100
	Population	0	24731	22539	822	48092
	Percentage	0.00	51.42	46.87	1.71	100
Kasaba	Villages	24	12	0	0	36
	Percentage	66.67	33.33	0.00	0.00	100
	Population	98226	27033	0	0	125259
	Percentage	78.42	21.58	0.00	0.00	100
Santemarahalli	Villages	0	28	9	3	40
	Percentage	0.00	70.00	22.50	7.50	100
	Population	0	47339	17239	6581	71159
	Percentage	0.00	66.53	24.23	9.25	100
Total	Villages	34	93	48	10	185
	Percentage	18.38	50.27	25.95	5.41	100
	Population	123490	157706	58882	17721	357799
	Percentage	34.51	44.08	16.46	4.95	100

Map 5.5 shows the accessibility to District Hospital in terms of distance. The number of villages, population and their percentage located within accessible zones are shown in table 5.6 which reveals that 34.51 percent of populations of 34 villages have access within the travel distance of less than 10 km; in this zone of accessibility the Kasaba and Chandakawadi hobli constitutes 78.42 and 35.50 percent of population respectively. People in Harave and Santemarahalli hobli do not have access to district hospital within the travel distance of less than 10 km. 93 villages which hold 44.08 percent of population of the district has access within the

travel distance of 10 – 20 km. in this zone of accessibility Santemarahalli holds the population of 66.53 percent followed by Haradanahalli (53.17), Harave (51.42) and Chandakawadi (50.23). 16.46 percent of population has access within the travel distance of 20 – 30 km. Highest population in this zone of accessibility is from Harave with 46.87 percent followed by Haradanahalli and Santemarahalli with 46.87 and 24.23 percent respectively. 5.41 percent villages with the population of the taluk have very less access as these villages have to travel more than 30 km to access district hospital in which 13.49 percent are from Chandakawadi and 9.25 percent from Santemarahalli.


Accessibility to District Hospital
(Travel Time - Min)
N
W
E
S
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
H
Legend
Village Centroids
< 17
17 - 34
34 - 51
> 51
Service Area
Travel Time (Min)
< 17
17 - 34
34 - 51
> 51
District Hospital
Road Network
Reserved Forest
0 2 4 8 12 16
Km

Map 5.6

Table 5.7: Accessibility to DH within specified Travel Time (Min)

Villages and their population within specified travel time (min)						
Hoblis		<17	17-34	34-51	>51	Total
Chandakawadi	Villages	13	15	4	1	33
	Percentage	39.39	45.45	12.12	3.03	100
	Population	35934	12145	6667	847	55593
	Percentage	64.64	21.85	11.99	1.52	100
Haradanahalli	Villages	6	14	16	4	40
	Percentage	15.00	35.00	40.00	10.00	100
	Population	13705	22612	17620	3759	57696
	Percentage	23.75	39.19	30.54	6.52	100
Harave	Villages	3	19	13	1	36
	Percentage	8.33	52.78	36.11	2.78	100
	Population	2853	28559	15858	822	48092
	Percentage	5.93	59.38	32.97	1.71	100
Kasaba	Villages	30	6	0	0	36
	Percentage	83.33	16.67	0.00	0.00	100
	Population	118572	6687	0	0	125259
	Percentage	94.66	5.34	0.00	0.00	100
Santemarahalli	Villages	4	28	5	3	40
	Percentage	10.00	70.00	12.50	7.50	100
	Population	4370	47466	12742	6581	71159
	Percentage	6.14	66.70	17.91	9.25	100
Total	Villages	56	82	38	9	185
	Percentage	30.27	44.32	20.54	4.86	100
	Population	175434	117469	52887	12009	357799
	Percentage	49.03	32.83	14.78	3.36	100

The accessibility zones to district hospital based on travelling time is shown in map 5.6. The population residing in different villages and their percentage located within different accessible zones based on driving travel time is shown in the table 5.7. The data reveals that majority of population with 49.03 percent of 56 villages have access within the driving time of less than 17 minutes. In this zone of accessibility the highest proportion of population is from Kasaba with 94.66 percent and 64.64 percent from Chandakawadi. 44.32 percent of villages with 32.83 percent population have access within the driving travel time of 17 to 34 minutes. The large population 66.70 percent have access in this zone is from Santemarahalli followed by

Harave with 59.38 percent and 39.19 is from Haradanahalli. There are 20.54 percent of villages with the population of villages with the population of 14.78 percent have access within the driving travel time of 34 to 51 minutes. Highest population in this zone of accessibility is from Harave with32.92 percent of population followed by Haradanahalli and Santemarahalli with the population of 30.54 and17.91 percent respectively. 4.86 percent villages with the population of 3.36 percent more than 51 minutes in which 9.25 percent of population is from Santemarahalli and 6.52 percent from Haradanahalli hobli.

5.6: Overall Accessibility to Health Centers

Using a network analysis tool, spatial accessibility of health centers based on travel time and travel distance was created for each health center, weighting was provided to each accessible zone as defined in Table 5.8. The raster overlay analyses were applied separately and finally all together for time and distance accessibility for each health center.

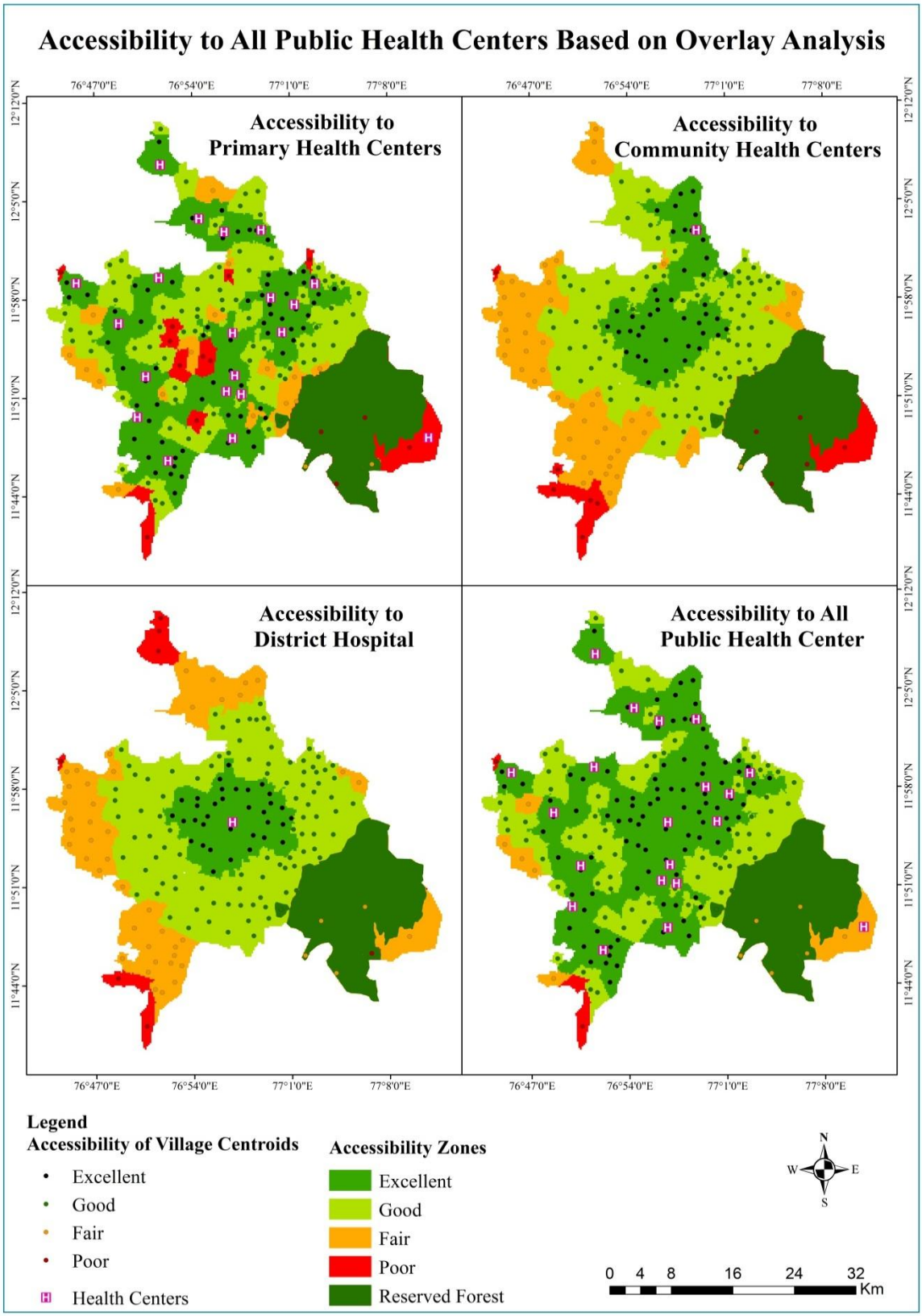
Table 5.8: Weightage assigned for different accessibility zones of Health Centers based on Time and Distance

	Primary Health Center		Community Health Center		District Hospital	
	Accessibility zone	Weightage	Accessibility zone	Weightage	Accessibility zone	Weightage
Distance (Km)	< 2	1	< 5	1	< 9	1
	2 – 4	2	5 – 10	2	9 – 18	2
	4 – 6	3	10 – 15	3	18 – 27	3
	6 – 8	4	15 – 20	4	27 – 36	4
Time (Min)	< 5	1	< 12	1	< 21	1
	5 – 10	2	12 – 24	2	21 – 42	2
	10 – 15	3	24 – 36	3	42 – 63	3
	15 – 20	4	36 – 48	4	63 – 84	4

Weightage: 1= Excellent; 2= Good; 3= Fair and 4= Poor

Table 5.9: Overall Accessibility to Health Centers

Hoblis		Excellent	Good	Fair	Poor
Chandakawadi	Population	32073	12380	4458	6682
	Percentage	57.69	22.27	8.02	12.02
Haradanahalli	Population	37714	12691	4450	2841
	Percentage	65.37	22.00	7.71	4.92
Harave	Population	21609	18835	6790	858
	Percentage	44.93	39.16	14.12	1.78
Kasaba	Population	78948	37035	1839	7437
	Percentage	63.03	29.57	1.47	5.94
Santemarahalli	Population	43748	21982	2642	2787
	Percentage	61.48	30.89	3.71	3.92
Total	Population	214092	102923	20179	20605
	Percentage	59.84	28.77	5.64	5.76


Accessibility to All Public Health Centers Based on Overlay Analysis
Accessibility to Primary Health Centers
Accessibility to Community Health Centers
Accessibility to District Hospital
Accessibility to All Public Health Center
76°47'0"E
76°54'0"E
77°1'0"E
77°8'0"E
12°12'0"N
12°5'0"N
11°58'0"N
11°51'0"N
11°44'0"N
Legend
Accessibility of Village Centroids
Excellent
Good
Fair
Poor
Health Centers
Accessibility Zones
Excellent
Good
Fair
Poor
Reserved Forest
N
W
E
S
0 4 8 16 24 32
Km

Map 5.7

The overall accessibility (Table 5.9) to all the health centers of the taluk based on both travel time and travel distance reveals that more than fifty percent of population of the district (59.84 percent) has excellent accessibility to all public health centers of the taluk out of that 65.37 percent is from Haradanahalli, 63.03 percent is from Kasaba, 61.48 from Santemarahalli, 57.69 from Chandakawadi and 44.93 percent of population is from Harave. 28.77 percent of population has good accessibility; in which 39.16 percent of population is from Harave, 30.89 percent is from Santemarahalli and Kasaba account for 29.57 percent of population. There is 5.64 percent of population with fair accessibility in which majority of population is from Harave with 14.12 percent followed by Chandakawadi with 8.02 percent and Haradanahalli with 7.71 percent of population. The poor accessible zone account for 5.76 percent of population of the taluk out of this 12.02 percent of population is from Chandakawadi and 5.94 percent is from Kasaba.

5.7: Conclusion

The emphasis in this chapter is on method and the usefulness of the results while calculating the physical accessibility to health centers. The data resulting from these analyses consists of 185 villages of five hoblis. There are 19758 (5.52 percent) people who have to make the travel distance of more than 15 km or travel time of 25 to 35 minutes to reach the basic or primary health center. Similarly 18.97 percent of population has to cover 27 km or more than 45 minutes to reach the CHCs. The situation is worst in case of DH in which 21.41 percent of population has to travel more than 51 minutes or distance of 30 km to visit the DH. The district's accessibility scenario differs between the hoblis. The result shows that accessibility in the study area has been greatly affected by the spatial distribution of health centers, the density of the road network and the topography of the region. This output can be used by health planners to gain a

better understanding about how health demand varies in all parts of the Taluk and have a better view about the existing condition of health demand. The spatial distribution of health centers and road network density are a function of the region's topography, which in turn demonstrates how resources are distributed.

CHAPTER - VI

SPATIAL PLANNING FOR HEALTH SERVICES

6.1: Introduction

Analysis of location-allocation is a geospatial process that allocates supply for a given population to reduce impedance. This approach can be used to consider how usage will be influenced by a shift in the distribution of existing resources. The problem of location requires the determination of a particular position or place for a particular purpose or operation. It requires the quest for a suitable place for an operation. The locational search issue can be named this issue. It is normal for the problem of locational search to be referred to as a problem of facility location. The placement of one operation (e.g. a retail store) or the placement of a collection of interrelated facilities (e.g. fire stations to serve an urban area) may entail this type of problem. Awareness, physical / spatial distribution and quality of health services, in which distribution and service barriers are components of how resources are distributed, are three common forms of barriers to health care usage.

Since the 1960s, a wide range of problems have been applied to location-allocation models, but with a general method of structuring service facilities to meet requirements in optimal ways (Ghosh & Rushton 1987). The location-allocation model is the mechanism that selects from a set of candidate locations the optimum location for facilities and, at the same time, assigns requirements to these locations in the most efficient way, based on the distribution of demands (Algharib S M, 2011).

The optimum position and allocation of facilities depends on demand and supply, where the demand is and where the facility is allocated, so the position and allocation need to be calculated simultaneously (Drezner, 1995). For public facilities preparing for the implementation

of a spatial decision support system, the application of GIS and location-allocation models can be a powerful tool. In doing so, by analysing various scenarios created under different assumptions, policy makers may make their selections successfully (Yeh & Chow, 1997). This is because the model of location allocation is very helpful in identifying the best choice of facilities by minimising the overall distance and time. In order to select the best location for recycling depots in the town of Dundas, located in southern Ontario, Canada, Valeo et al., (1998) used the maximum coverage model in location allocation. They concluded that models of location-allocation would provide a better viewpoint for local planners and engineers to select the optimum locations for public facilities. On the other hand, in 1987, Tewari & Jena applied the same model to boost the geographical accessibility of schools in Karnataka's Bellary district, India. They minimised the total distance travelled by the population to the nearest school and maximised the population covered within a predefined threshold of 8 km in order to reach their target and identify the best locations. In addition to being important in the placement of new facilities, location-allocation models are also helpful in evaluating and improving the effectiveness of past location decisions. (Rahman & Smith, 2000).

The decision to locate the facility is one of the concerns in the planning. It is a mix of two complications. First, where do we locate the facility, referring to the location? And secondly, the layout, which demonstrates how the facilities are relatively located within a chosen location? Methodologies have been developed to position a limited number of stations (Church and Revelle 1974), and others have been built to position the number of stations required to meet all criteria (Plastria 2002). Models of location-allocation have a very useful and essential approach that can be used to find the best places (Keane & Ward, 2002). The P-median problem is one of the basic types of the location-allocation model. It minimises the number of travel distances

between the demand points and the nearest service facilities in this design. Fotheringham et al . (1995) examined the sensitivity of the outcome to the concept of areas for which demand is calculated from the P- median method and reported that the best locations for facilities tend to be based on the definitions of the areas for which data can be collected.

The allocation model utilises the neighbourhood's maximum spatial and non-spatial details. An initial and simpler form of the location-allocation modelling procedures given by Hakimi in 1964 is the Capacitated p-Median Problem (CPMP) or minimum impedance problem. Numerous experiments have been attempted using mathematical programming to identify the optimal positions. The issue of minimising impedance is to find suitable locations for a number of particular facilities such that the total weighted impedance amount is reduced. This implies that the demand is assigned to a facility, multiplied by the facility's impedance. The purpose of applying this model is to decrease the total distance or time travelled to reach the points of demand. Church & ReVelle first formulated the Maximal Covering Location Problem (MCLP) in 1974. It aims to find the optimal positions within the impedance cutoff for a defined number of facilities that cover as many specifications as possible.

Both the classical P-median problem models and the MCLP take Euclidian distance into account and do not take the obstacles into account. While the GIS position allocation model's interaction with these models offers a spatial decision support mechanism and can support a broad range of spatial queries that can be used to help position studies but calculate accessibility to the facility along the roads, it does not take into account the accessibility of the walk other than roads.

6.2: Methodology

Different parameters such as land use / land cover, topography, road network, physical

barriers, population coverage capability, village settlement spatial distribution, population spatial distribution, location of established health facilities, travel scenario, travel path, etc. were modelled in the GIS domain using the AccessMod ® 5 software package developed by World Health Organization (WHO). The model was refined in the current study to fit local conditions by using a grid cell size of 1 hectare.

6.3: Generation of Input Layers

(i) Health facility

The list of health facilities in Chamarajanagara taluk was provided by the state health and welfare services, Government of Karnataka. GPS survey was conducted to generate the point data of health facilities of the taluk.

(ii) Land Cover Grid

From 2014 IRS LISS-III satellite images, the LULC map of the area was created. In addition, by digitizing features from Google Earth, a road network map of the area and physical barriers (river) was created and the data was cross-checked with the topographical map of the area for the accuracy assessment. The road network map was merged with the LULC map while it was masked out as a physical barrier map and a 100 m x 100 m grid scale LULC grid was created with forest, scrub, cultivated, river and snowfall grades. Using AccessMod 5, which automatically generates the travel scenario text file for study, the road network and barriers have been incorporated into the land cover grid.

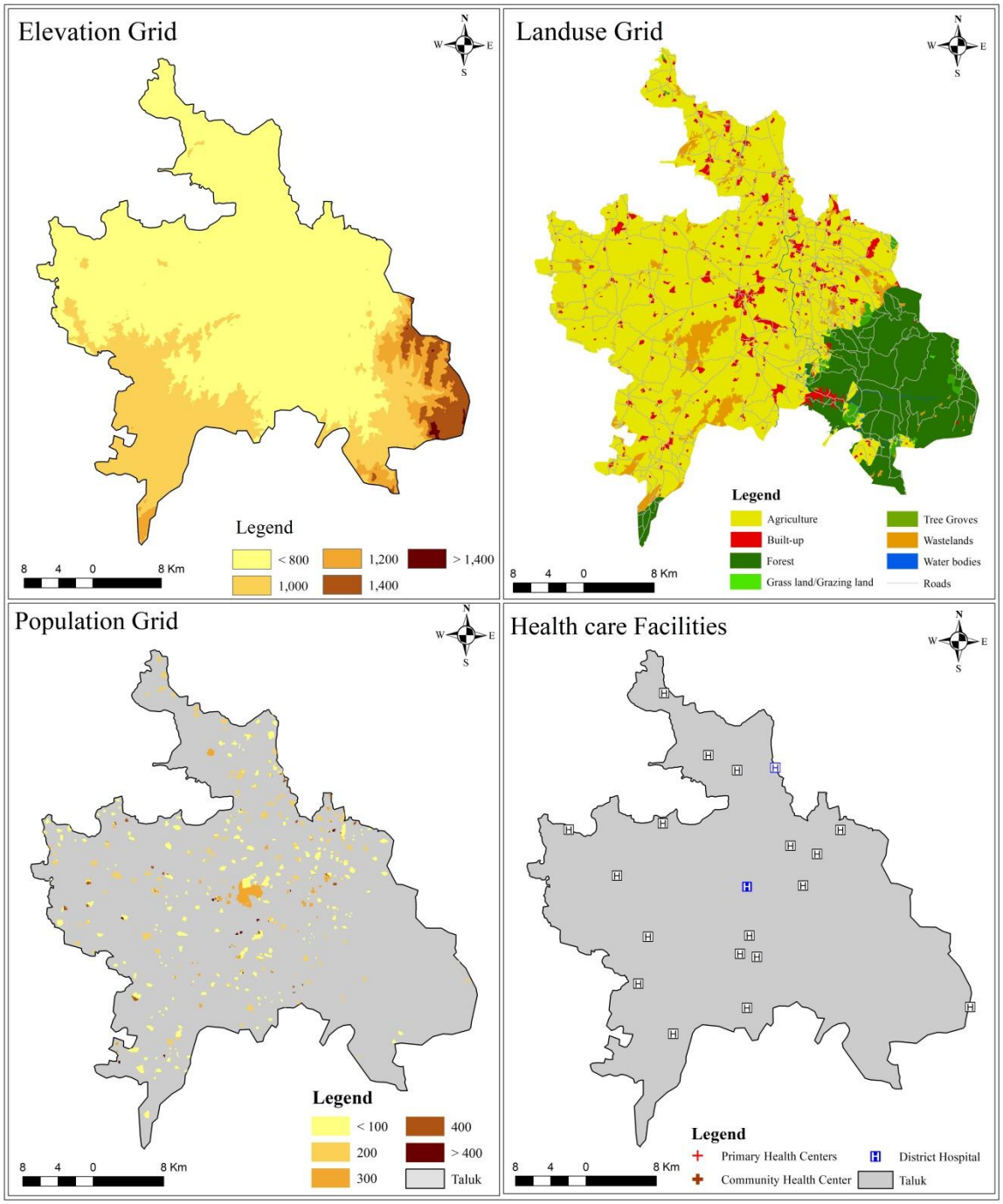
(iii) Population Grid

The census population is also called spatial census population grid if it is represented in the form of a spatial grid where each cell represents a value corresponding to its position on the ground. The scale of village settlements was digitized from high-resolution Cartosat-1 imagery

in the present study and combined with geographically referenced 100 m x 100 m fishnets. The population value of villages has been tagged to the grid vector layer as per the 2011 census. The vector layer was rasterized using 1 hectare of cell size after checking the population values of the village settlements randomly with the corresponding aggregate values of the cells in the grid vector layer.

(iv) Digital Elevation Model

Using ASTER (30 m) data, a digital elevation model (DEM) was developed. Using the same projection parameters and cell size as the LULC grid and population grid, the DEM was converted to the Grid format. For the analysis of patient movement across the varying topography, the DEM was required.



Map 6.1: Dataset Used for AccessMod Analysis

(v) Travelling Scenario

It is beneficial to integrate the mode of transportation and speed of travel of the patient across various landscape characteristics and topographical variations while modeling physical accessibility to the healthcare network. For this, as one of the inputs for analysis in the model, a travelling scenario text file was created. In the land cover grid type, the text file links with its associated speed of travel. For this, speed adjustment is indicated under the column, "Model", either NONE or WALKING. No slope correction is applied in the case of highways, as highways typically pass along the contours.

Table 6.1: Travelling Scenario text File

		Automotive Passenger Transport		Walking	
Classes	Land cover type	Speed	Model	Speed	Model
1	Agriculture	3	WALKING	3	WALKING
2	Built-up	4	WALKING	4	WALKING
3	Forest	2	WALKING	2	WALKING
4	Grass land/Grazing land	3	WALKING	3	WALKING
5	Tree Groves	3	WALKING	3	WALKING
6	Wastelands	3	WALKING	3	WALKING
7	National Highway	60	NONE	5	WALKING
8	State Highway	50	NONE	5	WALKING
9	Metalled	25	NONE	5	WALKING
10	Unmetalled	15	NONE	5	WALKING

(vi) Population Coverage Capacity (PCC)

It refers to the capacity of health centers corresponding to the population it serves (Ray and Ebener 2013). The population coverage norms issued by the National Health Mission

(NHM) recommends that a sub center should cover a population of 3,000, PHC 20,000 and CHC 80,000 in hilly / tribal areas. In addition, to facilitate the modeling exercise, the following assumptions were made:

The minimum population coverage capacity was calculated by considering that if 70 percent of PCCs were reached, a facility would still be cost-effective (Ray and Ebener 2013).

Table 6.2: Population Coverage Capacity

S. No.	Health facility Type	Min. Population	Max. Population	PCC
1	Primary Health Center	0	20000	14000
2	Community Health Center	20001	80000	56000
3	District Hospital	80001	99999999	714780

6.4: Modeling Spatial Accessibility

The spatial modeling has been carried out to delineate the catchment areas of the existing health facility network. Input data for such analysis include existing health facility; population grid; land cover grid and travelling scenario table generated by model 1; digital elevation model and health facility population coverage capacity. The model calculates the population around each of the health facility type and measures its extent on the basis of travel time and population coverage capacity set in the health facility attribute table. The model processes all health facilities one by one during in which the model controls each health facility not exceeding the population coverage capacity of health facility with the predefined time and finally delineates the corresponding catchments. The catchment of each facility gets generated at the maximum capacity of each facility. When the model completes its iterations, the results are displayed in the form of polygons representing catchment area for the existing health facility network and new population grid that depicts the population that is not yet covered by the existing health facilities.

Sustainable Development Goal 3 (SDG 3) aims to ensure healthy lives and promote well-being for all at all ages. This implies a health system that is well-functioning and provides promotional, preventive and curative care. When moving towards Universal Health Coverage (UHC), the establishment of a physical infrastructure through which quality health care services can be provided is a basic requirement. Ensuring the affordability, accessibility and responsiveness of health services to the needs of individuals and communities has a direct effect on health outcomes.

AccessMod is a toolbox that has been developed to help countries examine their health system's geographical aspects. In particular, it addresses the first three layers of a well-known framework created by Tanahashi (1978) to evaluate the coverage of health services (the specific three layers are: target population, coverage of availability and coverage of accessibility). AccessMod facilitates the detection of deficiencies and vulnerabilities with regard to meeting target audiences by determining how physically available the existing health system is. In addition, AccessMod makes it possible to test various options aimed at expanding (scaling up) the existing health care delivery network in order to expand population coverage, thereby directly supporting the planning processes and informing the implementation of UHC and SDG 3 policies.

More specifically, AccessMod uses geography's integrative capacity as well as Geographic Information Systems' (GIS) visual and analytical capabilities to:

1. Assess how current health facilities are available functionally to the target population - Study of physical accessibility

2. Estimate the proportion of the target population that would have physical access to existing facilities but could not receive care due to human or equipment capacity shortages - Geographic analysis of coverage

3. Measure travel time and distances between health facilities to measure, for instance, the time needed to refer to a higher level facility or deliver supplies to a facility from a supply store - Referral analysis

4. Identify physical accessibility coverage at sub-national level (i.e., percentage of the population with physical access to health facilities within a given time) and this for different user-specified travel times - Zonal statistics

5. Design and simulate various scenarios to expand the existing service delivery network to increase population coverage - Scaling-up analysis

(i) Physical Accessibility Analysis:

The Accessibility Analysis allows you to calculate the spatial distribution of travel time, taking into account the specified maximum travel time, to or from the nearest health facilities considered in the analysis.

Landscape constraints and the moving scenario table that determines the travel speeds for each of the land cover groups combined are also taken into account in this study. However, in this study, the spatial distribution of the target population is not taken into account because it has no effect on travel time.

(ii) Geographic Coverage Analysis:

The analysis of geographic coverage allows the availability of services (i.e. the capacity of health facilities to care for patients) to be taken into account and considered, in addition to physical accessibility constraints, in order to define the area of catchment associated with each

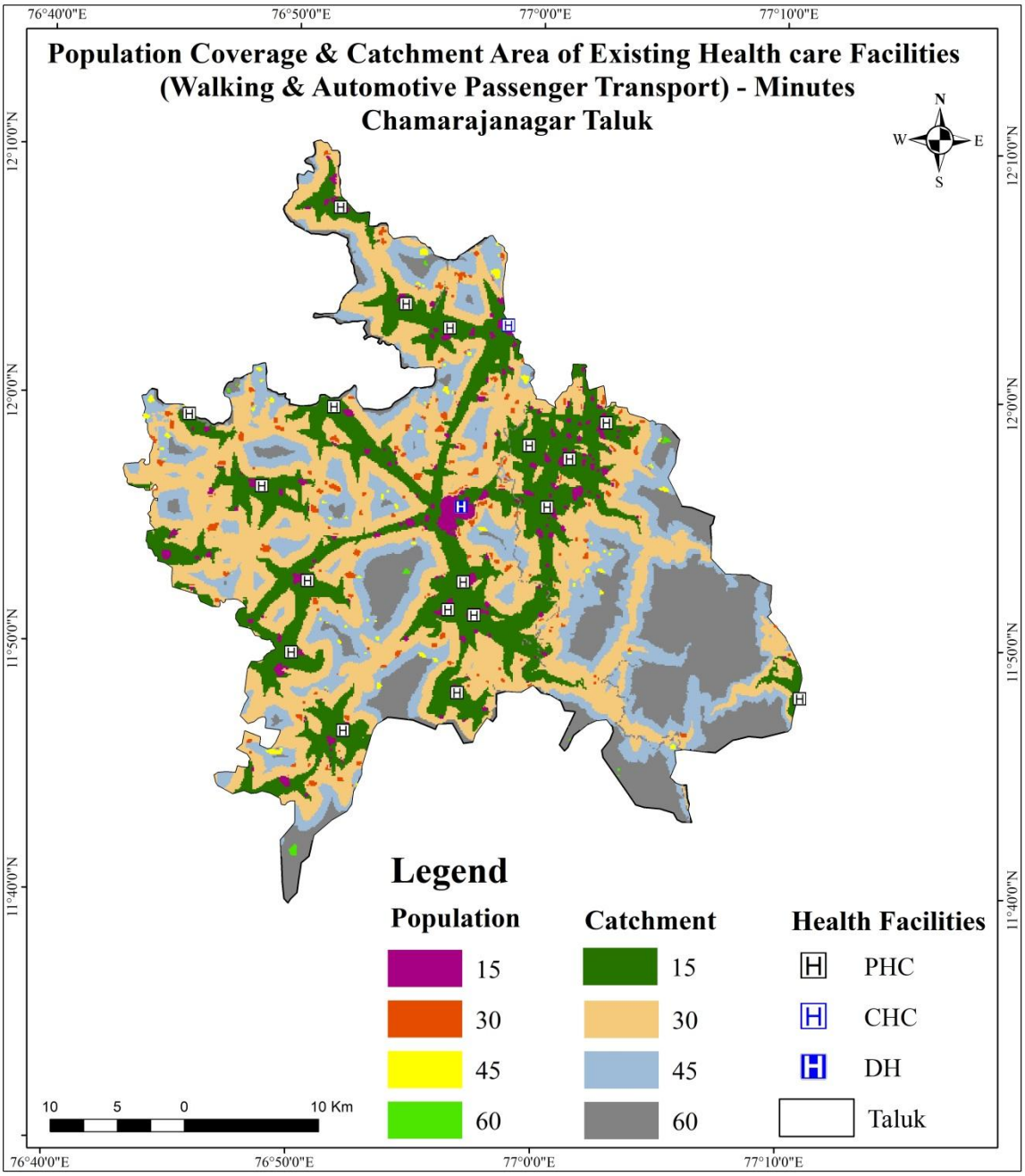
health facility.

The catchment area would, in other words, be:

- Extend until the maximum travel time has been reached (e.g. 120 minutes) if the population within the catchment is less than or equal to the health facility's approximate capacity.
- Not exceeding the maximum travel time (e.g. 120 minutes) if the population exceeds the approximate capacity of the health facility within that catchment. In such a case, the catchment will be smaller and will cover the size of the population corresponding to the health facility's estimated capacity.

(iii) Referral Analysis

The referral analysis helps one to measure the travel times and/or the distances between two groups of health centers along the least costly routes (i.e. the route between two places that minimizes the overall travel period for those travelling along it, see Ray and Ebener, 2008). This direction varies from a straight line as it takes into account the constraints of the terrain along with the population's travel modes and speeds. For instance, in a given province, one would like to know the distance and travel time between each primary health care facility and the nearest referral hospital.


Population Coverage & Catchment Area of Existing Health care Facilities
(Walking & Automotive Passenger Transport) - Minutes
Chamarajanagar Taluk
N
W
E
S
76°40'0"E
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
Legend
Population
15
30
45
60
Catchment
15
30
45
60
Health Facilities
PHC
CHC
DH
Taluk
10 5 0 10 Km

Map 6.2

Table 6.3: Population Coverage & Catchment Area of Existing Health Facilities by Walking & Automotive Passenger Transport within specified travel Time (Min)						
		< 15	15 to 30	30 to 45	45 to 60	Total
Chandakawadi	Population	23089	24813	6118	1573	55593
	Percentage	41.53	44.63	11.00	2.82	100
Haradanahalli	Population	16675	28223	11300	1498	57696
	Percentage	28.90	48.91	19.58	2.59	100
Harave	Population	15897	26129	5523	543	48092
	Percentage	33.05	54.331	11.48	1.12	100
Kasaba	Population	83705	30573	9564	1417	125259
	Percentage	66.82	24.40	7.63	1.13	100
Santemarahalli	Population	36063	27869	4533	2694	71159
	Percentage	50.67	39.16	6.37	3.78	100
Taluk	**Population**	**175429**	**137607**	**37038**	**7725**	**357799**
	Percentage	**49.03**	**38.45**	**10.35**	**2.15**	**100**

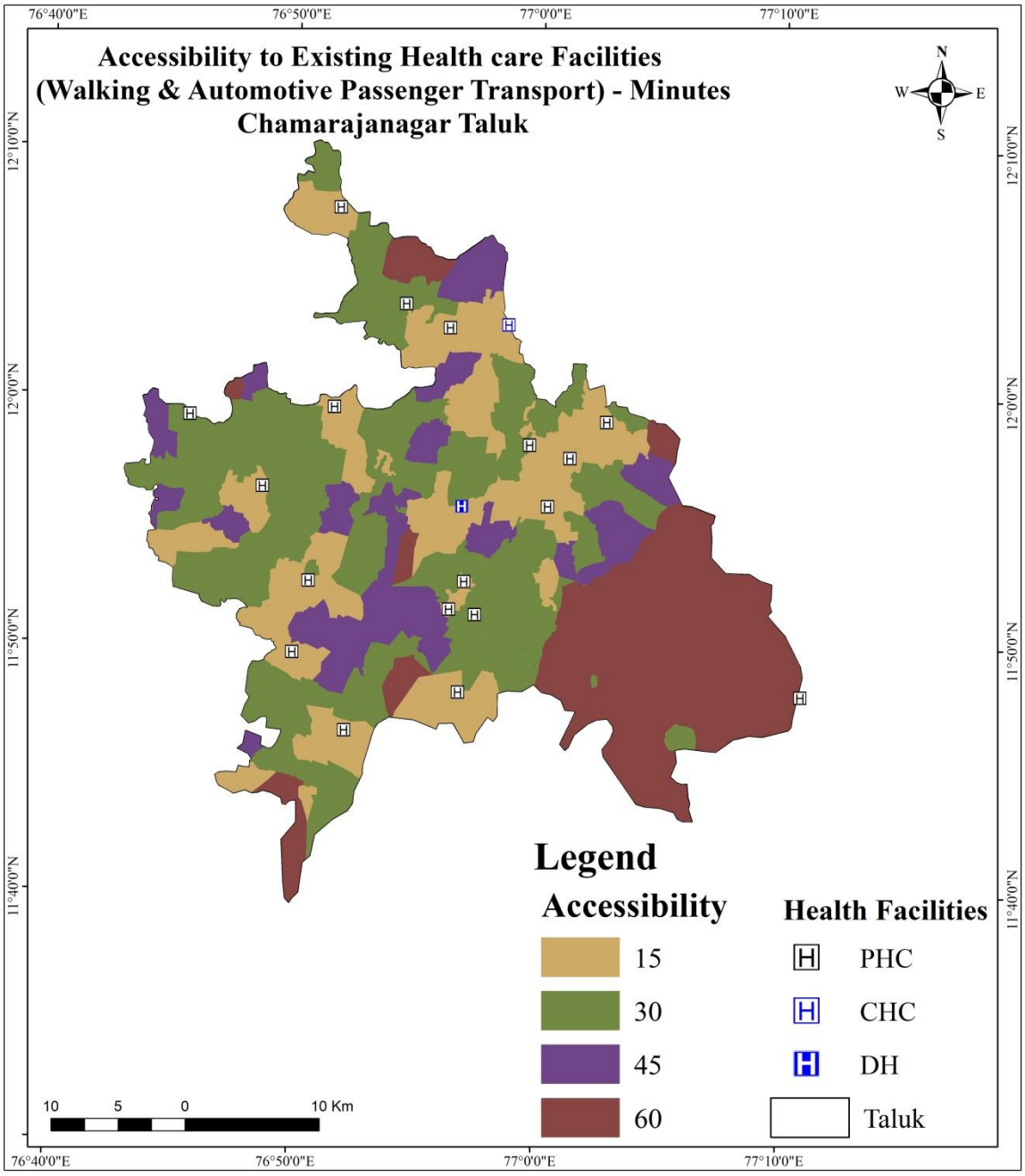
(iv) Zonal Statistics

Zonal statistics allow the population accessibility coverage (expressed as a percentage of the total population) to be obtained at the level of the zones uploaded during the project, by combining the travel time distribution grid obtained by the use of the 'accessibility analysis' method with the spatial distribution of the target population and the zones' boundaries.

This tool is especially interesting because it allows one to get the coverage of various travel times interactively as long as this travel time is within the maximum travel time defined when the accessibility analysis is performed. Accessibility study for a maximum travel time of 30 minutes has been carried out.

If maximum flexibility is needed to explore the evolution of the accessibility coverage for various travel times, an accessibility study should be carried out without restricting the maximum travel time (i.e. placing '0' in the 'maximum travel time field') and using the resulting travel time distribution grid in the current zonal statistics tool. We will simply use the 30-minute travel time

distribution grid previously obtained while using the "Accessibility review" tool for "the following exercise."



Map 6.3

(v) Scaling Up Analysis

The scaling-up study enables one to evaluate various scenarios to scale up an existing service delivery network or, if none is already in place, create a full service delivery network.

It takes into account the situations that can be evaluated by using this tool:

- Exclusion areas where it is not permissible to locate new health facilities
- Various geographically dispersed suitability variables are incorporated in the suitability index to identify the most appropriate locations for a new health facility to be located. The distance to / from particular characteristics, travel time to / from characteristics, population density or the description of places where health facilities should be prioritized relative to other facilities may be dependent on these variables.

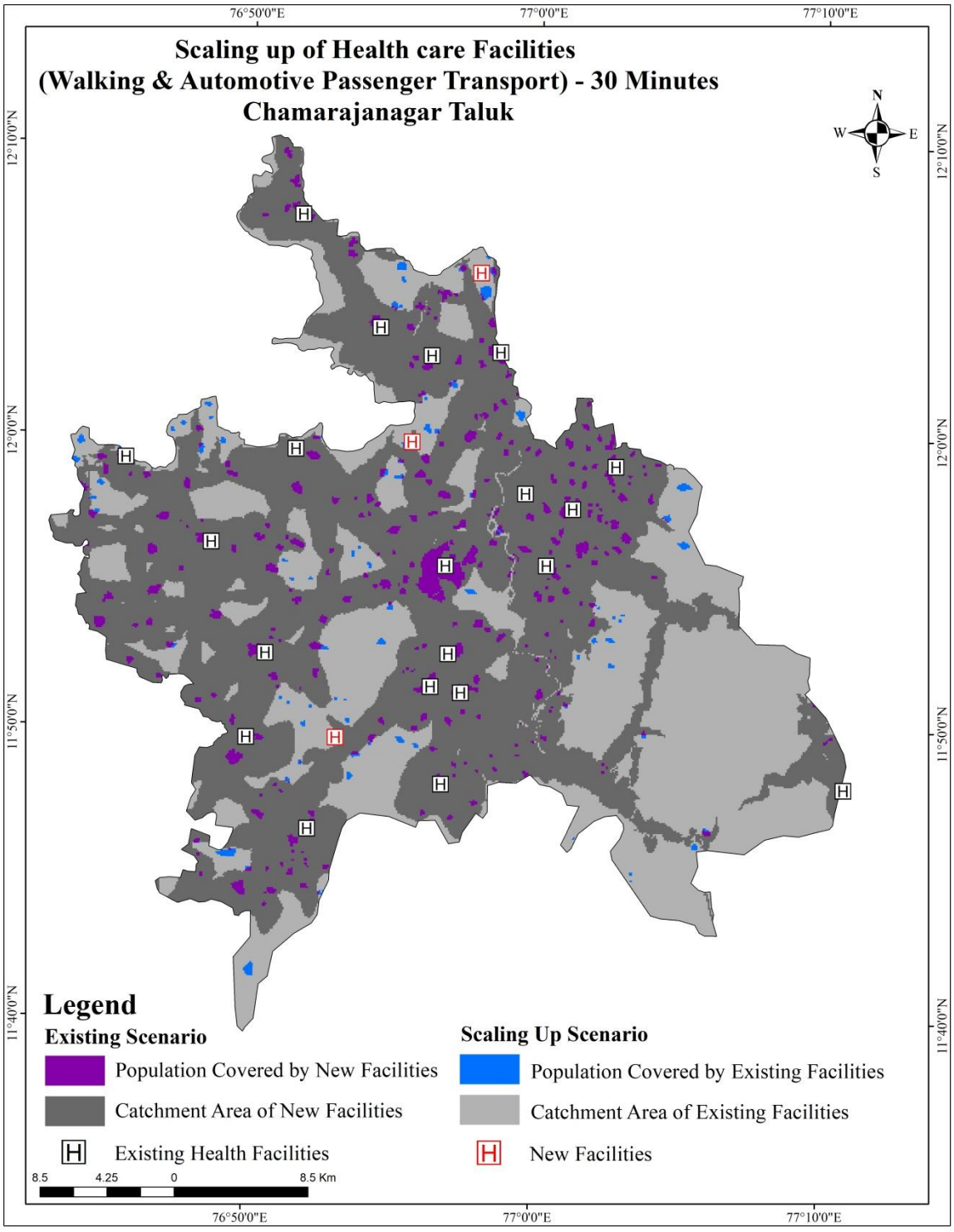
A physical accessibility analysis is then performed on all the raster cells with the highest value in the suitability distribution layer, beyond the exclusion areas.

The location (cell) covering the highest population is the one chosen for a new health facility to be located. Based on the content of the new health facility information table, the type of facility put on this site is then determined. The above is repeated until:

- Either the number of user-defined new health facilities have been located; or,
- It has surpassed the population coverage set by the user.

Table 6.4: Accessibility to Existing Health Facilities by Walking & Automotive Passenger within the travel Time of 30 Minutes				
	Covered Population	Percentage	Uncovered Population	Percentage
Chandakawadi	48002	13.41	7591	2.12
Haradanahalli	45098	12.60	12598	3.52
Harave	42026	11.74	6066	1.69
Kasaba	114058	31.87	11201	3.13
Santemarahalli	64032	17.89	7127	1.99
Taluk	313216	87.53	44538	12.44

The accessibility to the nearest health facility based on walking and automated scenario reveals that 12.44 percent of population of the district is still unserved. Among hoblis large proportion of unserved population is from Haradanahalli (3.52) and Kasaba (3.13) hoblis followed by Chandakawadi, Santemarahalli and Harave with 2.12, 1.99 and 1.69 percent respectively.


Scaling up of Health care Facilities
(Walking & Automotive Passenger Transport) - 30 Minutes
Chamarajanagar Taluk
76°50'0"E
77°0'0"E
77°10'0"E
12°10'0"N
12°0'0"N
11°50'0"N
11°40'0"N
N
W
E
S
Legend
Existing Scenario
Population Covered by New Facilities
Catchment Area of New Facilities
Existing Health Facilities
Scaling Up Scenario
Population Covered by Existing Facilities
Catchment Area of Existing Facilities
New Facilities
8.5 4.25 0 8.5 Km

Map 6.4

Table 6.5: Existing and Scaled-up Health facilities among Hoblis

Hoblis	Existing Health Facilities	Scaled-up Facilities
Chandakawadi	4	0
Haradanahalli	6	1
Harave	3	0
Kasaba	1	1
Santemarahalli	4	1
Total	18	3

The aim of this study was to meet the needs of the district's unattended population created by the software in Model 5 in the form of a new population grid. As with model 5, this model's output includes new health facilities, catchment areas of these health facilities, new population distribution in the form of new population in grid format, and distribution of population coverage as coverage. The model was replicated until it included all unattended populations and no population value was found in the new population grid. The study area requires 3 additional health facilities to serve all unattended populations within the drive time of 30 minutes. Out of that, 1 facility will be set up in Haradanahalli, 1 in Kasaba and 1 in Santemarahalli.

By studying healthcare network connectivity at the taluk level, the model might be able to scale up the network near a district's boundary as it is already served by a health facility on the other side of the boundary. The research also shows that the mode of transportation plays an important role in determining community access to the healthcare system. Furthermore, it was discovered that in many cases, the catchment areas of established healthcare facilities overlap. This is due to the previous unscientific and irrational geographic distribution of health institutions. As a result of this unequal distribution of facilities in the past, although some

villagers enjoy access to numerous health facilities others face difficulties due to the non-availability of even a single facility within acceptable travel time.

However, a large number of sub-centers have been discovered in the city, where there are excellent tertiary healthcare facilities available. On the other hand, in hilly area, patients are facing a lot of hardships because of the non-availability of facilities within reasonable travel time. Though it would be desirable to relocate the entire current healthcare network to eliminate overlapping catchments and the total number of sub-centers so that the money saved could be used to upgrade facilities at appropriate sites, this is not feasible.

6.5: Conclusion

The most significant accomplishment of this research is that the usefulness of geo-informatics has been demonstrated in the planning of healthcare networks at the local level, especially in areas where populations are dispersed across hilly and inaccessible terrain. Multiple parameters such as patient speed of travel across varying landscape features, spatial population distribution, terrain complexity, road connectivity, travel time, the patient direction of travel, population coverage capacity, and the impact of physical barriers on patient movement have been used to demonstrate a methodology for planning healthcare networks at the local level so that people from all walks of life can access healthcare. As a byproduct, a methodology for converting tabular population data into a spatially referenced one-hectare cell-sized grid in which each cell represents the corresponding population on the ground has been created. This has far-reaching consequences for government planning in other areas. Because the methodology is based on a freely downloadable package, it is cost-effective and can be replicated in other developing countries, with the potential for future refinements.

CHAPTER - VII

SUMMARY AND CONCLUSION

7.1: Introduction

Healthcare is one of the key components of growth, so the promotion and security of people's healthcare are vital to achieving and maintaining such a component. The focus of the discussion has been on health center distribution, physical accessibility, utilization and spatial planning in the last four chapters. The present chapter aims to summarize the analysis, capsuling the key conclusions and recommendations of the report. The section also addresses some of the guidelines that could help to allow proper use of the study area's health centers.

The thesis is divided into seven chapters. Introduction to the research topic, statement of the research problem, objectives, methodology and research organizations are included in the first chapter. A comprehensive literature review on various aspects of the study, such as delivery, accessibility, use and planning of health centers, is given in the second chapter. The geographic history, physiography, environment, demographic aspects and the socio-economic scenario of the study area are discussed in the third chapter.

The Fourth Chapter explains the Distribution of Healthcare Centers in Chamarajanagara taluk. Various statistical methods (Location quotient and Lorenz curve) have been used in this chapter to calculate the unequal distribution of health centers around the district's medical blocks. To assess if the available workforce and health infrastructure facilities are suitable for the population of the district, the ratio of health employees and health infrastructure facilities to the population of the district has been measured. The comprehensive scenario of accessibility to district health centers at the village level is presented in the fifth chapter. Different approaches were used to calculate accessibility in terms of time and distance, like GIS as network analysis.

By using AccessMod 5, the sixth chapter assesses the accessibility which involves land use, road network, population coverage capacity, topographical variation and ultimately provides spatial planning for the establishment of new health centers. The thesis is summarized in the seventh chapter and the key findings and conclusions of the research are mentioned, as well as some suggestions for further improvement of the study field, with a positive emphasis on sustainable development.

7.2: Findings

Chapter – IV: Distribution of Health Centers

The study reveals that the health centers particularly PHC‘s and SC‘s are not equally distributed among the hoblis of the Chamarajanagara taluk. The analysis of the location quotient of PHC‘s in Haradanahalli hobli shows that there is an excess of PHC‘s in proportion to the population size. The Location quotient value in Chandakawadi, Harave and Santemarahalli Hoblis indicates that the facilities are self-sufficient for their population. In Kasaba hobli the facilities are deficit compared to the population size of the population. Similarly, the analysis of the location quotient of SC‘s in Harave, Santemarahalli and Chandakawadi shows that there are more SC’s available to its population, while in Haradanahalli and Kasaba Hobli the value is less than 1, which reveals that the facilities are deficient to the population.

The distribution of health centers suggests that the district has a decent number of PHCs as the health center population ratio is contained under the NHM norm. The unequal distribution between the hoblis of health centers represents the difference in the norms of the PHC population ratio and the highest ratio is found in the Kasaba hobli. Whereas the SC population ratio illustrates the high population burden on such health centers as opposed to the prescribed levels, the block-level situation has also been found to be almost identical. Similarly, the ratio of

facilities and health workforce to population among the taluks is also considered higher than the prescribed levels.

Chapter – V: Accessibility to Public Health Centers

The entire region of interest has varied and undulating terrain, slope and steepness. The physical characteristics have greatly influenced the location and nature of health centers, road density, type of roads, road conditions, etc. The physical accessibility in Chandakawadi is comparatively lower as a result of its rugged and steep slopes thereby leading to a lesser number of health centers and lower road density. The contrasting situation is observed in Haradanahalli and Harave where the land is comparatively less undulation thereby providing a better opportunity for the development of good roads and higher availability of public health centers. Therefore the physical accessibility is greatly enhanced in these hoblis. However, the moderate accessibility prevails in Kasaba and Santemarahalli hoblis as a result of moderate nature of ruggedness, thereby making the road density comparatively better than Chandakawadi facilitating the provision of public health facilities which are grossly moderate in all respects.

The accessibility to PHCs based on both travel time and travel distance reveals that nearly 60 percent of the population of the district has excellent access; nearly 28 percent population have good access; 5 percent of the population have fair access to PHCs; the poor accessible zone accounts for almost 5 percent of the population of the taluk.

The overall accessibility to CHCs in the district based on both the dimensions (time and distance) nearly 41 percent population of the district are availing good accessibility. More than 40 percent of the population has excellent access; nearly 15 percent of the population has fair access to such facility; the poorly accessible zone holds 4 percent of the population of the district.

Overall accessibility to DH reveals that the majority of the population nearly 45 percent of the district has good access. More than 34 percent of the population has excellent access; around 18 of the population have fair access and the poor accessible zone holds almost 3 percent of the population of the district.

Overall accessibility to all the health centers of the district based on both travel time and travel distance indicate that more than 60 percent of the population of the district has excellent accessibility; nearly 28 percent of the population have good accessibility; 5 percent have fair accessibility and poor accessible zone accounts nearly 5 percent population of the district.

Chapter – VI: Spatial Planning for Health Services

The geographical coverage of health centers was taken within the travel time of 30 minutes. The area beyond 30 minutes walking travel time may be considered to be not practicable for the people to utilize the health centers. Hence all such areas are considered as unserved areas. The analysis also reveals that more than 12 percent of land area is unserved.

There is a need to plan for locating health centers in such unserved areas for that there is a requirement of Three New health facilities in the district within the drive time of 30 minutes. Out of that, 1 facility will be set up in Haradanahalli, 1 in Kasaba and 1 in Santemarahalli.

7.3: Conclusion

This study is intended to examine the various dimensions of the district's public healthcare services, so the provision of sufficient health facilities is important in all aspects of the use of healthcare. Economic status, profession, faith, education and gender have a significant effect on the perceived need for medical treatment and affect the use of healthcare.

Although the population ratio of primary health centers is according to prescribed norms, the sub-centers represent different situations in which the ratio is higher than the norms. The

taluk's spatial distribution of health centers (PHCs and SCs) shows the unequal distribution between the hoblis. According to expectations, the supply of health staff and the availability of facilities are often not adequately accessible.

Although the district has a large number of health centers, more than sixty percent have excellent coverage, but residents still have to travel a lot to access basic health services in all three blocks. Accessibility variance has been largely due to the distribution of health facilities, elevation and district road density. Accessibility is observed higher in Haradanahalli, followed by Kasaba and Santemarahalli, taking into account all these variables.

The study revealed many constraints impacting the use of health centers, such as factors that can be related to both demands, including the socio-economic status of people, and the quality of health services included on the supply side.

While assessing the accessibility of public healthcare services, it was shown that AccessMod offers the best results that not only test it by walking through various landforms and transport but also takes into account the capability of health centers. Besides, the scaling-up model available in AccessMod can be useful in many areas of healthcare planning, health administration, health facilities governance. Therefore, the necessities of area-specific policies need to be highlighted, including raising the number of health centers and the gradation of infrastructure services, as well as increasing the workforce.

7.4: Suggestions

- Physical Barriers and capacity of health facility has to be taken into consideration while demarcating the service area of healthcare facility.
- Better health care system demands up gradation of necessary facilities with increasing manpower.

- To avoid the negative effects of politically motivated allocations on accessibility to essential service centers in a particular region, political favoritism needs to be diminished.
- It is need of the hour to make people aware about their faith and myths with respect to social constraints so to make the proper utilization of public health centers.
- Mobile healthcare facilities need to be established in the areas mainly in the hilly region.

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Appendix– 1
GPS Location of Health Centers

Sl No	Health Centers	Latitude	Longitude	Elevation (in mtr)
1	Aluru	N 11˚58’225”	E 076˚59’554”	693
2	Amachawadi	N 11˚51’460”	E 076˚56’121”	746
3	Arakalawadi	N 11˚46’426”	E 076˚52’139”	864
4	Aralikatte	N 11˚59’439”	E 076˚45’407”	727
5	Bedaguli	N 11˚49’29”	E 077˚6’35”	789
6	Bisilawadi	N 11˚48’412”	E 076˚56’711”	830
7	Chandakawadi	N 11˚55’192”	E 077˚1’200”	690
8	District Hospital	N 11˚55’633	E 076˚56’543”	709
9	Doddinduwadi	N 12˚9’105”	E 077˚12’476”	689
10	Hallikerehundi	N 12˚7’521”	E 076˚51’857”	698
11	Harave	N 11˚56’312”	E 076˚48’414”	768
12	Heggadahalli	N 11˚52’810”	E 076˚41’113”	770
13	Kottalawadi	N 11˚49’19”	E 076˚49’554”	876
14	Kuderu	N 12˚2’654”	E 076˚56’245”	699
15	Padaguru	N 11˚51’308”	E 076˚44’315”	797
16	Panyadahundi	N 11˚59’601”	E 076˚51’548”	760
17	Sathemarahalli	N 12˚20’106”	E 076˚58’530”	716
18	Udigala	N 11˚52’404”	E 076˚50’79”	820
19	Ummatthuru	N 12˚3’751”	E 076˚54’310”	705
20	Venkayyana Chatra	N 11˚51’581”	E 076˚57’426”	725

Appendix – II
Health Administration Service Area

Sl. No	Name of PHC	Work Type	No of Villages	Area in Sq KMs	Population
1	Aluru	24X7	10	32	26264
2	Arakalavadi	24X7	11	78	15123
3	Bisilawadi	24X7	7	42	10150
4	Chandakavadi	24X7	13	56	32065
5	Hallikerehundi	24X7	4	34	11165
6	Haradanahalli	24X7	7	42	42261
7	Honganuru	24X7	11	57	24162
8	Kagalavadi	24X7	5	17	14337
9	Kottalavadi	24X7	6	53	10650
10	Kuderu	24X7	9	45	14511
12	Panyadahundi	24X7	19	98	32777
13	Udigala	24X7	14	79	15369
14	Ummatturu	24X7	4	46	11980
15	Venkaiahnachatra	24X7	4	24	12489
16	Santemarahalli	CHC	12	67	23753
17	Amachavadi	PHC	7	70	12830
18	Aralikatte	PHC	13	64	16666
19	Bedaguli	PHC	4	11	10109
20	Harave	PHC	7	54	21138

Appendix – III
Health Workforce

Id	Name_PHC	Doctors	Nurses	ANM	Lab_tech	Pharmasist	Group_D	Driver
1	Aluru	1	1	8	1	1	1	1
2	Amachawadi	1	0	3	0	0	0	0
3	Arakalawadi	1	0	6	1	0	1	0
4	Aralikatte	1	0	4	0	1	1	0
5	Bedaguli	0	0	0	0	0	0	0
6	Bisilawadi	1	0	0	0	0	0	0
7	Chandakawadi	1	1	9	2	1	1	0
8	Hallikerehundi	1	0	3	1	0	1	0
9	Haradanahalli	1	0	9	1	1	1	1
10	Harave	1	1	9	1	1	1	0
11	Honganooru	1	0	7	1	0	1	0
12	Kagalawadi	1	0	9	1	1	1	0
13	Kottanavadi	1	1	3	1	1	1	1
14	Kuderu	1	0	8	0	1	1	1
15	Panyadahundi	1	1	10	1	1	1	0
16	Santemarahalli	3	7	11	1	2	3	2
17	Udigala	1	1	8	1	1	1	0
18	Ummatturu	1	0	4	1	1	1	1
19	Venkayyana Chatra	1	1	3	1	1	1	0

Appendix – IV
Overlay Analysis Weightage

Sl No	Hoblis	Villages	PHC	CHC	DH	ALL
1	Chandakawadi	Punajanur	3	4	4	3
2	Chandakawadi	Honnegowdanahalli	3	3	3	3
3	Chandakawadi	Punajuru State Forest	4	4	3	4
4	Chandakawadi	Haradanahalli District	3	2	2	3
5	Chandakawadi	Malledevanahalli	2	2	2	2
6	Chandakawadi	Ayyanapura	2	2	2	2
7	Chandakawadi	Puttanapura	2	2	2	2
8	Chandakawadi	Hondarabalu	2	2	2	2
9	Chandakawadi	Nagavalli	1	2	2	1
10	Chandakawadi	Nallur	2	2	2	2
11	Chandakawadi	Kokkanahalli	2	2	2	2
12	Chandakawadi	Hanchithalapura	1	2	2	1
13	Chandakawadi	Chandakavadi	1	1	1	1
14	Chandakawadi	Vagarapura	1	1	1	1
15	Chandakawadi	Kagalavadi	1	2	2	1
16	Chandakawadi	Saraguru	1	1	1	1
17	Chandakawadi	Mallupura	1	1	1	1
18	Chandakawadi	Hosahalli	1	2	1	1
19	Chandakawadi	Alur	1	1	1	1
20	Chandakawadi	Jyothigowdanapura	2	2	2	2
21	Chandakawadi	Devarajapura	2	2	2	2
22	Chandakawadi	Dollipura	2	2	2	2
23	Chandakawadi	Karadihalla	1	2	1	1
24	Chandakawadi	Kodimole	1	1	1	1
25	Chandakawadi	Kulluru	4	4	3	4
26	Chandakawadi	Nagavalli	1	2	2	1
27	Chandakawadi	Karadihalla	3	2	2	3
28	Chandakawadi	Malledevanahalli	3	2	2	3
29	Chandakawadi	Devarajapura	2	2	2	2
30	Chandakawadi	Attagulipura	2	2	2	2
31	Chandakawadi	Hongalavadi	3	2	2	3
32	Chandakawadi	Bedaguli	4	4	3	4
33	Chandakawadi	Mukanapalya	4	4	3	4
34	Haradanahalli	Madalavadi	3	4	4	3
35	Haradanahalli	Yaraganhalli	4	4	4	4
36	Haradanahalli	Shindaiahanapura	2	4	3	2
37	Haradanahalli	Yanagumba	2	4	3	2
38	Haradanahalli	Kuthanapura	1	3	3	1
39	Haradanahalli	Mudala Hosahalli	1	3	3	1
40	Haradanahalli	Achattipura	2	3	3	2
41	Haradanahalli	Kilagere	1	3	3	1

42	Haradanahalli	Yanagahalli	1	3	3	1
43	Haradanahalli	Sanegala	2	2	2	2
44	Haradanahalli	Yanagahalli	1	3	3	1
45	Haradanahalli	Manchagundipura	1	3	3	1
46	Haradanahalli	Arakalavadi	1	3	3	1
47	Haradanahalli	Linganapura	1	3	3	1
48	Haradanahalli	Chowdahalli	1	3	3	1
49	Haradanahalli	Narasamangala	1	3	3	1
50	Haradanahalli	Bokkepura	2	3	2	2
51	Haradanahalli	Vaddagalapura	2	3	2	2
52	Haradanahalli	Yalachagere	2	3	2	2
53	Haradanahalli	Hagalabele	4	3	2	4
54	Haradanahalli	Kotaganahalli	1	1	1	1
55	Haradanahalli	Amachavadi	1	2	2	1
56	Haradanahalli	Bandigowdanahalli	1	3	2	1
57	Haradanahalli	Basthipura	1	2	2	1
58	Haradanahalli	Bisalavadi	1	2	2	1
59	Haradanahalli	Hagalabele	2	3	2	2
60	Haradanahalli	Channappanapura	1	2	2	1
61	Haradanahalli	Kodiugane	1	2	2	1
62	Haradanahalli	Bommanahalli	2	2	2	2
63	Haradanahalli	Bevinathalapura	3	2	2	3
64	Haradanahalli	Srirangapura	1	2	2	1
65	Haradanahalli	Venkataiahna Chatra	2	2	2	2
66	Haradanahalli	Ankanasettypura	1	2	2	1
67	Haradanahalli	Haradanahalli	1	1	1	1
68	Haradanahalli	Narasamangala	2	2	2	2
69	Haradanahalli	Byadamudlu	3	2	2	3
70	Haradanahalli	Vaddarahalli	1	3	3	1
71	Haradanahalli	Kothalavadi	1	3	3	1
72	Haradanahalli	Amachavadi	1	2	2	1
73	Haradanahalli	Kilagere	2	4	3	2
74	Harave	Maduvinabeedu	1	3	2	1
75	Harave	Devalapura	2	3	3	2
76	Harave	Udigala	1	2	2	1
77	Harave	Thammadahalli	1	2	2	1
78	Harave	Kumachahalli	3	3	3	3
79	Harave	Kanchanahalli	2	3	3	2
80	Harave	Kengaki	3	3	3	3
81	Harave	Sagade	2	3	3	2
82	Harave	Bettadapura	3	3	3	3
83	Harave	Haraganapura	2	3	3	2
84	Harave	Padnakuduhosahalli	2	3	3	2
85	Harave	Kulagana	2	3	3	2

86	Harave	Hirebegur	1	3	3	1
87	Harave	Aralikatte	1	3	3	1
88	Harave	Kebbepura	4	4	4	4
89	Harave	Chikkabegur	1	3	3	1
90	Harave	Kilalipura	1	3	3	1
91	Harave	Heggavadi	2	3	2	2
92	Harave	Bujaganapura	2	3	3	2
93	Harave	Kerehalli	2	3	3	2
94	Harave	Mukkadahalli	2	3	2	2
95	Harave	Govindavadi	1	2	2	1
96	Harave	Kalanahundi	2	2	2	2
97	Harave	Maliyuru	3	3	3	3
98	Harave	Kethanapura	1	2	2	1
99	Harave	Mudnakodu	2	3	3	2
100	Harave	Kethahalli	1	3	3	1
101	Harave	Harave	1	2	2	1
102	Harave	Nanjedevanapura	2	2	2	2
103	Harave	Hangarepura	1	2	2	1
104	Harave	Veeranapura	2	2	2	2
105	Harave	Somanapura	4	2	2	4
106	Harave	Uganedahundi	1	3	2	1
107	Harave	Kumbaragundi	2	2	2	2
108	Harave	Harave	2	2	2	2
109	Harave	Kumbaragundi	3	3	2	3
110	Kasaba	Chamarajanagar	1	1	1	1
111	Kasaba	Bendaravady	2	2	2	2
112	Kasaba	Hanahalli	3	3	2	3
113	Kasaba	Yalakkur	2	2	2	2
114	Kasaba	K.Mookahalli	2	2	2	2
115	Kasaba	Kasturu	2	2	2	2
116	Kasaba	Sappaiahnapura	4	2	1	4
117	Kasaba	Nanjahalli	1	2	2	1
118	Kasaba	Muthige	1	2	2	1
119	Kasaba	Badanaguppe	1	2	2	1
120	Kasaba	Kellamballi	2	2	2	2
121	Kasaba	Bhogapura	2	1	1	2
122	Kasaba	Kiragasur	2	1	1	2
123	Kasaba	Masagapura	2	1	1	2
124	Kasaba	Madapura	2	1	1	2
125	Kasaba	Handarakalli	1	2	1	1
126	Kasaba	Heggotara	2	2	2	2
127	Kasaba	Bedarapura	2	1	1	2
128	Kasaba	Somasamudra	4	1	1	4
129	Kasaba	Kattepura	2	1	1	2

130	Kasaba	Shivapura	4	2	2	4
131	Kasaba	Yadapura	3	1	1	3
132	Kasaba	Uthavalli	4	1	1	4
133	Kasaba	Mallaiahnapura	4	1	1	4
134	Kasaba	Mariyala	2	1	1	2
135	Kasaba	Gangavadi	2	2	1	2
136	Kasaba	Chamarajanagar [R]	2	1	1	2
137	Kasaba	Managanahalli	1	1	1	1
138	Kasaba	Kadahalli	3	1	1	3
139	Kasaba	Mangala	2	1	2	2
140	Kasaba	Kudalur	2	1	1	2
141	Kasaba	Boodithittu	1	1	1	1
142	Kasaba	Basavanapura	2	1	1	2
143	Kasaba	Ramasamudra Rural	2	1	1	2
144	Kasaba	Somanapura	1	1	1	1
145	Kasaba	Doddamole	2	1	1	2
146	Santemarahalli	Melmala	2	3	2	2
147	Santemarahalli	Thimmegowdanapalya	2	3	3	2
148	Santemarahalli	Hanumanapura	2	3	2	2
149	Santemarahalli	Bettahalli	1	2	2	1
150	Santemarahalli	Honganoor	1	2	2	1
151	Santemarahalli	Hosapura	2	2	3	2
152	Santemarahalli	Chatipura	2	2	2	2
153	Santemarahalli	Kallipura	2	2	2	2
154	Santemarahalli	Suthur	2	2	2	2
155	Santemarahalli	Erasavadi	4	2	2	4
156	Santemarahalli	Boodamballi	1	2	2	1
157	Santemarahalli	H.Mookahalli	1	2	2	1
158	Santemarahalli	Thelanur	2	1	3	2
159	Santemarahalli	Banahalli	2	1	3	2
160	Santemarahalli	Bagali	3	2	3	3
161	Santemarahalli	Kamaravadi	2	1	3	2
162	Santemarahalli	Aldur	2	3	4	2
163	Santemarahalli	Navilur	1	3	4	1
164	Santemarahalli	Ganaganur	1	3	4	1
165	Santemarahalli	Jannur	2	2	3	2
166	Santemarahalli	Ummathur	1	2	3	1
167	Santemarahalli	Mudala Agrahara	2	2	2	2
168	Santemarahalli	Demahalli	1	1	3	1
169	Santemarahalli	Kuderu	1	2	2	1
170	Santemarahalli	Heggavadi	1	1	2	1
171	Santemarahalli	Kavudavadi	2	1	2	2
172	Santemarahalli	Heggavadipura	1	1	2	1
173	Santemarahalli	Desavalli	1	1	2	1

174	Santemarahalli	Basavatti	1	1	2	1
175	Santemarahalli	Santhemarahalli	1	1	2	1
176	Santemarahalli	Kotamballi	1	1	2	1
177	Santemarahalli	Kempanapura	2	1	2	2
178	Santemarahalli	Kannegala	1	2	2	1
179	Santemarahalli	Gulipura	1	1	2	1
180	Santemarahalli	Homma	1	2	2	1
181	Santemarahalli	Rechamballi	2	2	2	2
182	Santemarahalli	Nanjarajapura	1	2	2	1
183	Santemarahalli	Singanapura	1	1	2	1
184	Santemarahalli	Suthur	1	2	2	1
185	Santemarahalli	Suthur	1	2	2	1

District Hospital, Chamarajanagara

Pharmacy in PHC

Waiting area in PHC

Hallikerehundi PHC

Blueprint of Aralikatte PHC and its villages

Panyadahundi PHC

ಕರ್ನಾಟಕ ಸರ್ಕಾರ
ಆರೋಗ್ಯ ಮತ್ತು ಕುಟುಂಬ ಕಲ್ಯಾಣ ಇಲಾಖೆ
ಜಿಲ್ಲಾ ಪಂಚಾಯತ್, ಚಾಮರಾಜನಗರ
ಪ್ರಾಥಮಿಕ ಆರೋಗ್ಯ ಉಪಕೇಂದ್ರ, ಹರವೆ
ಹರವೆ 'ಎ'
ಚಾಮರಾಜನಗರ ತಾ॥ ಮತ್ತು ಜಿಲ್ಲೆ.

ಪ್ರಾಥಮಿಕ ಆರೋಗ್ಯಕೇಂದ್ರ ಹರವೆ
ಉಪಕೇಂದ್ರಗಳ ವಿವರ
ಉಪಕೇಂದ್ರದ ಹೆಸರು
ಗ್ರಾಮಗಳು
ಜನರ ವಿವರ
1 ಹರವೆ 'ಎ' ಜೆ. ಪದ್ಮ
ಹರವೆ. ಹುಲ್ಲೇಪುರ (1911) (1111)
ಜನ.ಸಂ. 3022
ಅಂಗನವಾಡಿ.. 07
ಆಶಾ.... 03
2 ಹರವೆ 'ಬಿ' ಪ್ರತಿಮಾ. S
ಹೊಸಹುಳ್ಳಿ. ಕೆಸ್ತೂರಹುಂಡಿ (168) (489)
ಹರವೆ (1896)
ಜನ.ಸಂ... 2553
ಅಂಗನವಾಡಿ.. 03
ಆಶಾ..... 02
3 ಕಲ್ಲೂರ ಉಮಮಹೇಶ್ವರಿ
ಕಲ್ಲೂರ. ದೇ.ಗೌ.ಪುರ (1408) (450)
ಜನ.ಸಂ.... 1858
ಅಂಗನವಾಡಿ.. 03
ಆಶಾ..... 02
4 ಕಾಳನಹುಂಡಿ ಹೆಚ್.ಎಲ್. ರಶ್ಮಿ
ಕಾಳನ ಹುಂಡಿ (2378)
ಜನ.ಸಂ... 2378
ಅಂಗನವಾಡಿ.. 04
ಆಶಾ.... 02
5 ನಂಜದೇವನಪುರ ಆರ್. ಗಾಯಿತ್ರಿ
ನಂಜದೇವನ ಪುರ (2183)
ವೀರನಪುರ (680)
ಜನ.ಸಂ... 2863
ಅಂಗನವಾಡಿ.. 04
ಆಶಾ.... 03
6 ಮಲೆಯೂರು ಹೆಚ್. ಚಂದ್ರಮ್ಮ
ಮಲೆಯೂರು. ಮುಕ್ಕಡಿಹುಳ್ಳಿ (2771) (1540)
ಜನ.ಸಂ.. 4361
ಅಂಗನವಾಡಿ.. 07
ಆಶಾ.... 05

Harave PHC